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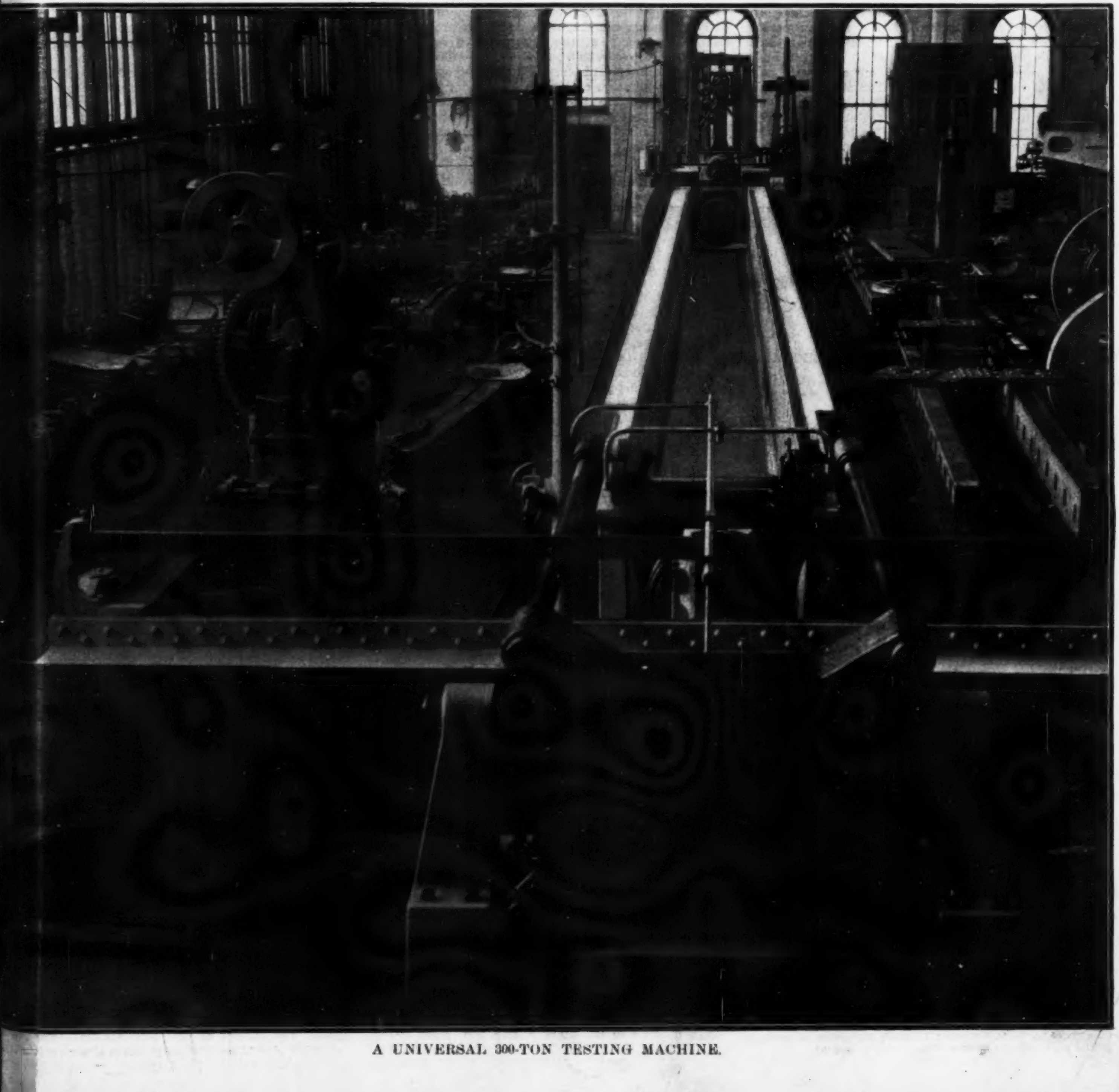
A UNIVERSAL 300-TON TESTING MACHINE.

By the English Correspondent of the SCIENTIFIC AMERICAN.

AN interesting description of a highly efficient new 300-ton testing machine was delivered before the recent congress of the British Association, by the inventor, Mr. J. H. Wicksteed, president of the Institute of Mechanical Engineers. This apparatus, which possesses several novel and ingenious features, as well as several improvements upon similar machines of this type, has been constructed by the designer's firm, Messrs. Buckton & Co., Ltd., of Leeds, and was recently opened by the French government at the Conservatoire Nationale des Arts et Metiers. The main advantage possible with this apparatus is that it enables testing to be carried further than with any other previous machine, since the strength of full-sized members of structures, instead of specimens, may be tested therewith. It will test a strut 88 feet long by 3 feet 3 inches wide by 3 feet 3 inches thick; a chain cable 13 fathoms long of $4\frac{1}{2}$ inches diameter iron; or a beam 3 feet 3 inches broad by 6 feet 8 inches deep and 20 feet between supports; while it will also test in single shear a bar 8 inches wide by $2\frac{1}{2}$ inches thick. Another very distinct advantage is its universal character. No change of parts or appliances has to be effected to accommodate it for testing in compression or tension, or to prepare it for taking long or short pieces, and this is accomplished by means of a simple single-acting ram which is always pressing in the same direction upon the short end of a lever of the first order. It adequately fulfills all those very functions for which such an appliance is requisite, with the minimum of time, labor, and expense. For instance, consider the expense that would be incurred by loading a girder with 300 tons dead weight. The weights alone, together with the necessary supports, would cost over $10,000, not taking into account the cost of the time and labor involved in loading and unloading the weights, which would result in the experiment costing several times as much as would be the case, were it effected with such a machine as this.

Primarily, this apparatus, in common with others of its type, comprises three principal parts—the apparatus which applies the load, the apparatus which measures it, and the frame or bed respectively. But there are two leading features which differentiate it from its prototypes. In the first place, the frame or bed is not a fixture, as in the general practice, but is movable, while the weighing levers are at the same end as the straining cylinder, which is contrary to the arrangement in the orthodox fixed-bed machine. It is this combination which supplies to the apparatus the facility characteristic of it for testing a wide variety of sizes either in compression or tension, deflection or shearing, without even the slightest alteration or any rearrangement of the machine.

The machine consists of a sliding trough, hydraulic ram, a novel balancing system floating upon rollers and not touching the sliding bed at any point. The balance delivers the load to a steelyard. The great convenience of the system is that the hydraulic ram moves a long frame, which is the length of the longest specimen capable of being tested. This straining frame is both surrounded and traversed by a balanc-



A UNIVERSAL 300-TON TESTING MACHINE.

ing frame, with the result that the straining crosshead can push on to one part of the balancing frame, and pull on to another part, and the straining crosshead can itself be run along the straining frame into a position for pushing or pulling either long or short pieces. The clip boxes in the straining head are spherical. One of the compression platens also has a spherical seat, which enables adjustment to be carried out to suit the end of a column—the two ends of which are not quite parallel. The apparatus is also fitted with a complete device for making autographic records of the work in hand. No matter what kind of test is in progress, a complete diagram is traced. The loads are recorded upon a large drum by the vertical displacement of a pen by means of a wire, which moves at the same time as the traveling poise weight on the steelyard, and an amount proportional to the displacement of the latter. There is a train of change wheels actuated by the hand-wheel controlling the traverse of the poise weight, and the motion of the pen can be regulated at will, so as to give a scale of ordinates of 10 millimeters, 5 millimeters, 2 millimeters, or 1 millimeter per ton. The deformation of the test piece is transmitted in abscissæ to the recording drum by suitable wires passing over pulleys which revolve the drum, so as to record the deformation either full size or multiplied five or ten times.

Severe trials have been made with the apparatus in France to demonstrate its capabilities in various directions. In order to test the water-tightness of the hydraulic ram, a tension of 32 tons was placed upon a steel bar one evening, and left till the following morning. Upon examination a tension of 30 tons was found, testifying therefore that the leakage past the piston was comparatively insignificant.

Its accuracy and sensibility were demonstrated by means of calibrated copper crushers. These were crushed previously in the most delicate machines in the laboratory, which had been carefully checked by dead weights for the purpose. The results were uniformly concordant, and no inaccuracy was noted. For tests as to sensibility, a load of 100 tons was applied to a long chain with the steelyard in equilibrium and halfway between the limits of its range, and then moving the poise weight on the steelyard a fraction of its travel corresponding to 4 pounds upon the steelyard. This amount plus or minus upset the equilibrium. When the apparatus was opened for operation, two typical tests were carried out. A bar of hard steel, 4 inches by 1½-inch section, was broken in tension, with a load of 228 tons, while a large slab of armored concrete, 32 inches broad by 12 inches thick, was broken in deflection between supports 16 feet 6 inches apart.

The machine can be accommodated to any variety of tests with celerity and facility, and can be operated with the minimum of labor, which are very important considerations. To pass from one test to another, the moving crosshead which runs upon wheels can be easily moved by one man, while locking the crosshead to the moving bed only occupies a minute. All the motions of the sliding bed, together with the adjustment of the poise weight on the steelyard, can easily be controlled by a single operator on the platform.

MODERN HIGH-SPEED PRINTING TELEGRAPH SYSTEMS.*

By J. C. BARCLAY.

MACHINE telegraphy is undoubtedly destined to play, if not a dominant, at least a highly conspicuous part in the telegraphy of the future. For the present, and probably for a long time to come, the Morse system will continue to be the standard system employed in this country. It is doubtful, indeed, if the Morse apparatus—representing, as it does, the very acme of simplicity—will ever be wholly superseded, but new and improved, as well as more economical methods of working, will, slowly perhaps, but nevertheless surely, limit its field of operations.

The advances made in recent years in the direction of developing and perfecting a printing-telegraph system, adapted to meet all the requirements of a modern telegraph service, have been of such a practical and progressive character as to leave no room for doubt that the successful advent of such systems into the domain of commercial telegraphy will soon be, if it is not indeed already, an accomplished fact.

Ever since the birth of telegraphy, the subject of printing-telegraph systems has more or less engaged the serious attention of electrical inventors, and, as a result of their efforts, quite a number of such systems have been devised and put into operation; but until quite recently their usefulness has, with few exceptions, been restricted to stock and market reporting or other enterprises of a more or less private and local character.

For the general telegraphic work of the country these systems are entirely too slow; they can only be successfully operated over limited distances, and their records are, as a rule, made upon a strip of paper which is regarded with anything but favor by the telegraphing public of to-day.

In the elements of weakness above mentioned lie the stumbling blocks to success, but of this the majority of printing-telegraph inventors appear to be entirely unconscious, judging from the way their energies are misdirected in continued efforts to develop and perfect a type of machine for which there is absolutely no demand in the great commercial departments of the telegraphic industry.

Many of the more recent inventions are based upon the principles embodied in the ordinary commercial typewriter, whose peculiar adaptability to the requirements of a telegraph printer was soon recognized, and whose advent into the art may be said to have marked the beginning of the new era of modern high-speed type-printing-telegraph systems.

It may be said of the majority of printing-telegraph contrivances based on the typewriter principle, that they are "fearfully and wonderfully made," but a few comparatively simple ones are to be found that can be operated at speeds higher than those attainable by any of the ticker systems, while at the same time making their records in page form instead of upon the objectionable paper tape. The maximum speed at which they can be worked, and the distances over which they can be satisfactorily operated are, however, so far below the requirements of the present telegraph service, that until they have become more highly developed along the lines indicated, their sphere of usefulness will be limited to enterprises outside the field of commercial telegraphy.

One principal source of weakness in connection with these moderately fast short-distance machines consists in the character of the signaling currents employed, which, as a rule, lack the necessary quality for overcoming the retarding and attenuating effects of the main line. Very short signaling impulses that differ greatly in strength with occasional changes in direction—as employed by some inventors—is not a current arrangement adapted to long-distance transmission. Nor is a combination of electrical impulses of one polarity and of uniform strength much better calculated to increase the signaling distance over lines of considerable inductive capacity, the tendency of which is to retard and absorb such impulses.

A much better plan to secure effective signaling is to incorporate into the system a method of reversing or alternating the line currents, and until inventors more fully realize the importance of some such arrangement, their chances for success in the direction of long-distance working will be highly problematical.

The superiority of the alternating-current method for printing-telegraph purposes has already been pretty well demonstrated, and this fact opens up the interesting question as to what particular extent such currents might be utilized with advantage in the working of ordinary telegraph circuits. It is well understood that the successful operation of these circuits is seriously handicapped by certain line-disturbing elements that are more likely to increase than to diminish in magnitude and intensity as the years roll by.

The leakage interference from the ubiquitous trolley lines constitutes, for instance, one of the growing evils that beset the telegraph engineer, while more or less trouble is to be apprehended from the development and extension of high-pressure transmission lines with their immense capacity for creating inductive or other disquieting influences. It is possible to exclude the former, and to modify the effects of the latter's interference by the use of condensers directly inserted in the main line, which arrangement would also wholly or partly rid the circuit of all ground currents and leakage currents from neighboring wires, as well as minimize the deleterious results arising from defective insulation, variations of resistance, capacity, etc. Such an arrangement, however, would be utterly impracticable with the ordinary battery currents, but, as the alternating signaling impulses can be easily transmitted through condensers, a combination of the character mentioned would seem to lend itself in a manner quite feasible to the practical exclusion of most of the disturbing influences to which all telegraph lines are more or less subjected.

Whether or not this principle will ever find a general application in ordinary telegraph working, it is certain that the subject is receiving considerable attention at the hands of telegraph inventors, several of whom have already succeeded in making practical applications of such a character as to suggest possibilities of the utmost importance in this new and promising field of telegraphic development.

Harking back to the subject of printing-telegraphs, it may be remarked that no matter what kind of transmitting current may be employed in connection therewith, a satisfactory system at the present time calls for page printing, at a high rate of speed, over considerable distances, and some few of the latest inventions pertaining to this particular art take note of these essential requirements.

The most highly developed specimens and best-known examples of this modern class of machines are those invented by Murray, Rowland, and Buckingham.

In the Murray system the messages are both transmitted and recorded mechanically through the medium of a typewriter. A perforated paper tape is first prepared by means of a keyboard mechanism, and is then run through a Wheatstone transmitter, which automatically, and at a high rate of speed, sends out the signaling currents to the distant receiving station. These currents are utilized, not to actuate the printing mechanism direct, as is the case with all other printing-telegraph systems, but to reproduce another perforated tape, the particular function of which is to mechanically control the working of a typewriter in a manner analogous to that by which a mechanical piano may be operated by a perforated band of paper. This is a highly novel and ingenious application, since the actual printing is accomplished locally, and without regard to the signaling currents coming over the line, but the use of the perforated tape at both the transmitting and receiving stations introduces an element of delay that is more or less objectionable, despite the rapidity with which the signaling currents may be flashed over the main wire.

In Rowland's printing arrangement there is no such objectionable feature, the transmitting apparatus having been designed to work directly into the line, and to operate the receiving mechanism in a manner equally direct. Direct transmission and reception is, in fact, one of the most desirable features in connection with the operation of any telegraph system, but when this is accompanied by a very large increase in the carrying capacity of the wire over which such system is worked, the latter may not unjustly be regarded as one coming well within the range of being an ideal method of working. Such, at least, are the views expressed by the advocates of Prof. Rowland's "octuplex system," and these views might be readily accepted if to the other admirable features of this "telegraphic wonder of the age" the great merit of simplicity could only be added.

The system is operated on the multiplex principle and requires that between certain corresponding parts of the rotating mechanism at each end of the line perfect synchronism be maintained. Success in this direction heretofore has only been practically accomplished over very short distances, with transmissions as numerous as those involved in the Rowland printing arrangement. It is claimed, however, that the difficulties previously encountered in the way of maintaining unison over considerable stretches of line have now been fully overcome by the use primarily of an alternating current continually flowing to line, which current not only provides for the necessary synchronizing impulses, but for the signaling impulses as well. The sending of the signals, it may be remarked, is actually accomplished not by supplying the line with current at the moment the signal is being transmitted, as in the ordinary telegraphic methods, but by cutting out certain of the alternating-current waves, the arrangement being such that one or more of these signals can be made to consist of a combination of suppressed half-waves, the signals so produced being then automatically translated into printed characters. In this way, and by grouping the waves in a manner admitting of entirely different and independent signals being sent from four Remington keyboards, each of the four transmitting operators employed can cut out four different wave combinations, and send as many different signals over the line in a single second. Forty words per minute is said to be an ordinary rate of speed for a practised operator using this system, or, since the system can be duplexed, eight times that number, making 320 words in all that may be sent and printed over a telegraph wire in the course of a minute. This, if practicable under the regular conditions of working, would make the Rowland system the fastest of all printing systems, or, what amounts to the same thing, it would be capable of more fully utilizing the electrical conductivity, or transmitting properties, of a wire than any other system of similar character.

That the Rowland machine has been very highly developed on the most modern and approved scientific principles is undoubtedly true, but it remains to be more fully demonstrated that an extremely complex system, necessitating the maintenance of the most perfect synchronism, and employing as many impulses as those required for the formation of each of the letters or characters, is one practically adapted to the working of other than circuits of moderate length.

To Mr. C. L. Buckingham belongs the credit of having invented the first really rapid, long-distance, page-printing mechanism that was ever successfully employed for the transaction of ordinary telegraph business. Many years had been spent by the inventor in an endeavor to devise and perfect a printing-telegraph machine that could be operated over practically unlimited distances, but it was not until the happy idea was conceived of utilizing the Wheatstone automatic system as a basis that success appeared in sight. Through the medium of the Wheatstone terminal and repeating apparatus, it at once became possible to transmit and receive the necessary signaling pulses over the longest telegraph lines, the pulses in this case differing from those of the Wheatstone or Morse in being quite definite in the number requisite to form the various characters, for each of which six electrical impulses alternating in direction are essential.

The distinguishing features of the invention consist of the perforating apparatus for preparing the slip for transmission, and the printer, which is placed in a local circuit arrangement at the receiving end of the line.

The operation of punching differs from that employed in the Wheatstone, in that it involves the use of a typewriting machine, by means of which anyone may manufacture the slip without the slightest knowledge on the part of the manipulator as to the particular code employed, and at a rate of speed considerably greater than that possible by the use of the Wheatstone perforator.

The slip thus prepared is then run through the Wheatstone transmitter, which automatically forwards the signals to the distant terminal station, where they are received upon a Wheatstone relay, and thence repeated into the local-circuit arrangement. In this circuit is a variety of relays and electromagnets which call into action a number of novel and ingenious contrivances of both a mechanical and electrical character. Under the control of the electrical impulses received over the line these devices perform their various func-

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tions with a regularity, precision and harmonious working of parts that is simply amazing.

One of these devices is a modified form of "sunflower" or current-distributing apparatus of very peculiar construction. It was especially designed to secure a rapid transmission or switching of certain line pulses through one or other of a series of relays connected to the sunflower. Five of these relays, known as "selectors," are employed for the purpose of actuating a corresponding number of electromagnetic "adjusters," which control the movements of the type-wheel. Short pulses do not affect the selecting relays, but when the pulses are sufficiently prolonged, the motion of the sunflower or distributor—which is normally one of rotation—becomes temporarily checked or arrested by means of an electromagnetic escapement, thereby permitting any such pulse to actuate the particular relay whose circuit is at that moment completed through contact arms on the sunflower.

At least one of the series of the six line pulses required to form a character must be prolonged, and the particular relay or number of relays that shall be affected within the time required to transmit the entire series of pulses is determined by the regular order in which such pulses are transmitted to the line. If, for instance, the first pulse be a prolonged one, the first in the series of relays with its corresponding "adjuster" will respond, and no other. Similarly, if the second pulse be lengthened, the second only in the group of relays will respond thereto, and so on. One or all of the selector relays may be involved in the operation of bringing any letter or character into the required position for printing, the impression itself being invariably accomplished through the medium of the sixth pulse. This pulse, the last in the series, is always a prolonged one of a certain definite polarity, and is not only utilized for the purpose stated, but also to start the feed mechanism, as well as to operate a dogging device which holds the type-wheel firmly in position while the impression is being made. It contrives, furthermore, to actuate the synchronizer, and thereafter to reset or restore to their normal positions such of the selecting and adjusting instruments as were brought into activity by the one series of line pulses, and to thus put them in a condition of readiness for the next cycle of operations.

The type-wheel is suitably mounted upon a shaft of such construction as to permit the wheel to move axially, or circumferentially, or in both directions simultaneously. Instead of a comparatively large wheel having the entire number of characters on its periphery and rotating all the way round, the inventor employs a small wheel bearing four rings or rows of type, which only rotate through a half revolution in either direction. The regulation of the type-wheel is effected through the action of the adjuster magnets, whose armature levers are connected with certain impelling or driving devices, some of which impart a rotary, and others a longitudinal motion, or a combination of both movements to the type-wheel. The axial, or longitudinal movements of the wheel bring any desired ring or row of type into line with the press pad, while the rotary movements shift the different type of a row or ring into the proper position for printing.

It is by such movements, either singly or in combination, that any type of the several rings may be brought to position on the completion of the requisite number of pulses.

The blanks upon which the messages are printed are the regular message forms whose edges have been pasted together, so as to give the blanks a tubular shape or appearance. When the printing of a message is about to begin, a tube is placed in position beneath the type-wheel by sliding it edgewise upon a brass tube, which serves as a support, and in which there is an opening to admit of the necessary operations and impressions taking place. The blank, when printed, is quickly slipped to one side and a fresh one takes its place, after which the first blank is removed from the support by opening it on the line where its edges are joined, and so on. These latter operations are performed by hand, and they constitute about the only ones, so far as the printer is concerned, that are not entirely automatic in character.

The Buckingham system may well be regarded as the most unique and original one in existence, and it will deservedly take high rank among the list of marvelous and useful telegraph inventions of the times. It has been in practical operation over the Western Union lines between New York and Chicago, and New York and Buffalo, for the last six years, and has a maximum working capacity of about 200 messages per hour, operated as a duplex. It does not, as will be noticed, utilize the transmitting properties of a wire to the same extent as that theoretically possible with the Rowland multiplex system, but it is successfully operative over distances that would not at all be practicable with any synchronous multiplex system as yet invented.

The Buckingham system possesses the disadvantage of requiring a perforated strip for transmitting purposes, but, as in the case of the Rowland, the received record is a direct one, instead of having to be translated, as in the Murray system. If the perforated tape could be entirely abolished, and a rate of speed obtained by direct manual transmission approximately equal to that obtained in actual practice by automatic working, a grave objection to the Buckingham system would be overcome, and the author is strongly of opinion that such a change is not only desirable, but entirely feasible, and is, in point of fact, well under way.

One other defect of the Buckingham system consists in the fact that the number of characters that can be printed by means of the type-wheel is limited to 32, admitting only of the letters of the alphabet and certain punctuation marks being recorded. To print all of the characters desirable for commercial-telegraph purposes would involve some radical changes in the apparatus and greatly increase the already complicated character of the system. By substituting for the present recording arrangement a modified form of electrical typewriter of great sensibility and rapidity in action, a comparatively simple printing mechanism can be devised that will more fully meet the service requirements along the lines indicated, and at the same time increase the legibility, and improve the general appearance of the printed message. This is what the author has set out to accomplish, and his experiments so far demonstrate that a speed of at least 100 words per minute can be readily secured thereby. The particular changes necessary to bring this about involve the use of as many small printing magnets as are requisite for the desired number of mechanical operations. As this particular arrangement is the subject of patent proceedings, nothing can be said further than to intimate that the printing magnets are actuated by local currents properly directed through the medium of certain electromagnetic selecting devices, whose particular function is to distribute the different signaling impulses among the various printing and auxiliary magnets in a manner appropriate to the requirements in the case.

In looking over its past history, one cannot but be struck with the fact, and take pardonable pride in the knowledge, that the printing-telegraph art constitutes an industry, the origin, growth and development of which may be credited almost exclusively to American inventors, whose persistent efforts, in the face of many difficulties and discouragements, have at last brought about an extension of its sphere of usefulness into the commercial branch of practical telegraphy. It may be reasonably assumed as a consequence thereof, that the technical and industrial development of this particular art will be much more rapid in the future than it has been in the past; but much remains to be done in the way of simplifying and more nearly perfecting the working apparatus in order to thoroughly complete the task of those early experimenters, who, some fifty years ago, first undertook to solve the problem of devising a practical, useful, as well as economical, printing-telegraph system.

THE TESTING OF LIGHTNING RODS.

ALL installations of lightning conductors ought to be tested at regular intervals, in fact it is a necessary procedure, first, because even important faults do not make themselves immediately apparent, and again, because experience has shown that when improvements in the buildings have been undertaken or annexes added, either the installation itself suffers injury or the original conditions, to cover which sufficient protection was figured out, have been changed.

Accordingly every year a test should be made, and the best season is in the spring before the customary storm period. The object of such an examination should be to determine in a general way whether or not, since the installation or a previous examination, any material changes had been made in the buildings or in the adjacent terrain which would call for an alteration of the system. Under this head it is of paramount importance to consider any new structures and to ascertain whether the number and partition of the rods provide sufficient protection, whether the conduction through the air is equal to the demand or the groundings still intact, whether more branches and connecting conductors are not needed, this more particularly after the introduction of new metal into the system, such as gas pipes, water pipes, well tubes, leaders, gutters, metallic cornices, etc.; whether a change in the ground-water level or the drainage system requires attention; finally the combination of buildings should be closely scrutinized in search for damp walls which might make necessary the erection of other rods on the threatened places. The succeeding examination is in part galvanic, and has to do primarily with the conductivity of the metal rods composing the installation, proving them according to a standard of admissible resistances, such testing to be done singly and in combination; on the other hand, it is mechanical and spreads itself over the entire system, demanding a critical examination for visible defects in the construction of the separate parts, their connections, the condition of the points, and with all the building protected. Both these examinations should go hand in hand, each should complement the other; either one undertaken alone must suffer on account of certain imperfections.

A satisfactory manner of making this mechanical examination of the conductors in the air shall receive our first attention; it must determine whether there is everywhere present a sufficient cross section of air conductor, or whether by reason of rusting out or other injuries, any decrease in the cross section of the metallic mass (over and above the admissible 25 per cent) has occurred since the preceding examination, whether the metal system hangs well together as a whole or is loose and shaky or has in fact become separated, being intact only in certain places; whether the anchoring supports in the buildings are still tight or have worked loose, for this latter condition may easily lead to friction and eventually to possible rupture of the rod. For the examination of inaccessible points, a strong spy-glass or terrestrial telescope may be used with advantage. Since the close examination of such inaccessible parts can only be performed upon expensively erected scaffolding, it is imperative that at each annual test the galvanic test or proof should be applied to all the conductors in the air.

If, through the latter process, it be established that the resistance of the system does not exceed a certain specified strength, then, presupposing a perfect or even a good grounding, it may be accepted as among the improbabilities that an electric bolt will penetrate into the interior of the building. To assure then the greatest possible security, it seems advisable that a close inspection of every part of the system above ground be undertaken within reasonable periods. From the above it will be seen that the yearly testing of the conductors above ground consists in a most careful mechanical examination by a galvanic test in which the telephone-bridge finds extensive application. The resistance between any two points of the system, recorded by the bridge, must in no case exceed one ohm.

We also advise that, within the period of five years, every part of the installation above ground be gone over carefully at least once. For this purpose the repairs on the buildings in whole or in part will afford the most convenient opportunity. Moreover, a searching mechanical examination of the entire system should take place after every discharge. To ascertain with a certainty whether or not a discharge has passed over the system, the addition of apparatus for registering such discharges would be very practical.

As for the examination of the groundings, the mechanical tests would confine themselves mainly to scrutinizing the effects of rust upon the connections between earth and air, and this can readily be accomplished by a little digging about the feet of the rods. The character of the blemishes, if any are disclosed, will give a line on the rest of the grounding.

Just here the galvanic test, at least in so far as it gives the resistances in numerical calculation, will be the best and most reliable means of determining the true value of that very important part of the system—the grounding; however, we do not maintain that the results obtained upon the basis of the aforesaid measurements of the galvanic current will express under all conditions the spreading resistances which come into play in cases of lightning discharges.

Only when the determined results, which vary according to the weather conditions and the season of the year, can be carefully compared with all the influencing circumstances, is it possible to arrive at the proper signification of the measurements of the spreading resistances of the earth. Thus after a prolonged season of wet weather, we shall find the resistances considerably less in groundings which are sunken in places that hold the moisture, while, on the contrary, they will be correspondingly greater after a season of drought. Average constant values under such conditions are best obtained from measurements taken in the spring and fall; during the winter the resistances are in general found to be higher than in summer.

If a comparison of a carefully prepared chart of the ruling measurements taken at any time with a later test of the grounding should disclose an unexplainably high spreading-resistance on the part of the earth, then all the data in hand show conclusively that the present mechanical examination points to a weakness in the character of the grounding. From the above, then, it may be said that also the following figures for the earth-spreading resistances, which represent only average conditions, must not be taken too exactly as limitations; they are produced rather as leaders, based upon extended experiments with a fair consideration of the practical demands.

More exact data concerning admissible maximum earth-spreading resistances will be possible after manifold measurements have furnished more material for observation.

For the present the values given below must suffice. The galvanic tests of the gas and water pipes should not show greater resistance than one ohm. (The recognized legal ohm is the resistance offered by a column of mercury 106 centimeters long, having a cross section of 1 square millimeter.) Nor should the other earth conductors, such as bodies of water and the streams that run into them, metal well tubes, ground water lying 10 meters below the surface, of course, only at such points where it comes near the foundations, which lie particularly near the building to be protected and which it is desirable to bring in closer connection with the system, disclose a possibly greater individual earth-spreading resistance than 15 ohms.

In conclusion, then, the scattering resistance of the combined lightning rod installation—the total earth-spreading resistance—should be considered under the presupposition that the parts above ground have been brought into the most intimate connection.

As for the water in the ground, when it lies 10 meters below the surface, an admissible total resistance would be 10 ohms; if it lie 40 meters below or even deeper, 40 ohms may be allowed. These figures will serve for extremes, and by actual testing out the values for shorter depths may be interpolated. Measurements already given can safely be applied to buildings exposing 500 square meters of surface; for such combinations as expose from 1,000 square meters to 1,500 square meters, it would be well to reduce them to one-half or one-third.—Translated from Allgemeine Chemiker Zeitung.

To Remove Inscriptions Burnt in Glass.—Blotting paper saturated with strong crude hydrochloric acid is laid upon the inscription, and in a few days the marks of letters will be removed. Then scour off with pumice stone powder.—Pharmaceutische Rundschau.

SIEMENS & HALSKE PRINTING TELEGRAPH OR TELECRYPTOGRAPH.*

By L. Ramakers.

Although wireless telegraphy has made very remarkable progress during the last two years, it seems as if it will be a long time before it dethrones ordinary electric telegraphy. In fact, the problem of wireless telegraphy is still too complex from the viewpoint of sure transmission to great distances, as well as from that of the secrecy of the dispatches, to cause telegraphy with wires, for the moment at least, to fear its young rival. This is so true that the Siemens & Halske establishment, far from abandoning as useless all ideas of introducing improvements into the ordinary systems of telegraphy now employed and which would certainly be destined to disappear on the day upon which the Marconi invention entered definitely into the commercial domain, has just presented to the German government some rapid telegraphic apparatus of an absolutely new type, which show a great improvement upon those that are at present generally employed.

The Siemens & Halske telecryptograph is an automatic telegraphic system. In this new system, as in the Wheatstone, Murray, and Pollak-Virag systems of rapid telegraphy, the telegram to be transmitted is first transcribed in perforations made in a paper ribbon. The perforating apparatus (Fig. 1) has the appearance of a typewriting machine, and may be easily manipulated without preliminary practice.

When one of the keys is pressed, the apparatus perforates the tape in two different places, and the holes formed represent the letter, number, or punctuation mark on the key pressed. Besides this, the letter itself is at the same time printed upon the upper edge of the ribbon, so that the telegrapher can control the perforated text at every instant. The tape is provided with eleven longitudinal lines in pairs in order to properly represent all of the letters and conventional signs. For example, the holes belonging to one letter, *h*, are upon the lines 3 and 6, those referring to another, *a*, upon the lines 4 and 9, etc. (Fig. 2).

Transmitter.—As soon as the operation of perforation is finished, the ribbon is drawn into an automatic manipulator (Fig. 3). This consists of an electric motor, *M*, which actuates a contact arrangement, *R*, as well as the mechanism that carries along the paper ribbon. The motor is coupled to a shaft to which is secured a contact arm that moves over a transmitting disk, *T*, divided into 12 contact segments insulated from one another. The dynamo, *G*, seen at the end of the shaft, serves as a current generator. The contact arrangement, *R*, of the automatic manipulator comprises 11 small movable rods, *t* (Fig. 4), placed side by side upon a hard rubber base, equally distant from one another and corresponding to the 11 lines of the perforated tape. Each of these rods is connected with one of the contact segments of the transmitting disk, *T*. The twelfth segment is grounded. Above each rod, *t*, is another rod, t_1, connected with the earth. In the inoperative position, that is to say, when no hole of the tape is beneath a contact rod, *t*, the latter are all in contact with their corresponding rods, t_1, and all the segments of the transmitting disk are therefore connected with the earth. But as soon as one of the steel pieces, *a*, fastened near their ends to the rods, *t*, falls into one of the holes, *P*, of the tape, the rod rests upon the corresponding contact, *c*. At this moment, the rod, *t*, falls away from t_1, breaking connection with it, as *t*, rests upon an insulated stop, *b*. The contacts, *c*, are connected with one another as well as with the tongue of the armature of the transmitter relay. A letter is telegraphed at every revolution of the motor, *M*. Let us, for example, take the letter *r*, and see how the operation is effected. As this letter corresponds to two holes formed in the lines 2 and 8 of the transmitting ribbon, the rods t_2 and t_8 will drop successively upon their corresponding contacts, c_2 and c_8. Then, as soon as the contact arm touches segment 2 of the transmitting disk, there occurs a current impulse which passes from the positive pole of the generator, *G*, through the positive contact and the tongue of the transmitter relay, to the contact, c_2, the rod, t_2, the segment, 2, and the contact arm of the transmitting disk, as well as through the windings of the transmitter relay to the commutation condenser and the earth. At the same time a portion of the current passes into the conducting wire. This first current impulse charges the commutation condenser; but when, an instant afterward, the contact arm, upon continuing its revolution, touches segment 3, the condenser is discharged again. The discharge current flows through the windings of the relay, the contact arm, segment 3 of the transmitting disk, and the rods *t*3 and *t*,3 to the earth. Since the discharge current has a direction contrary to that of the charge current, the tongue of the armature of the transmitter relay is then thrown over to the negative contact, and, at the same instant, the direction of the current sent into the line wire likewise changes.

The same thing takes place, but this time beginning with a negative current impulse, when the second hole (formed upon line 8 of the transmitting tape) passes under the steel piece of the contact rod.

The motive mechanism of the transmitting tape is so calculated that each turn of the motor, *M*, causes a forward movement of the tape corresponding to one letter. Since each letter or sign is formed by two holes, the current passing through the wire changes direction twice at every complete revolution of the contact arm.

The automatic commutation of the transmitter relay is effected only when the segment for which there is a hole in the tape succeeds a segment connected with the earth; otherwise the discharge current of the commutation condenser, and consequently the throwing over of the relay armature tongue against the other contact, would not occur. Segment 12 of the transmitting disk thus serves, for example, as a commutating one for contact segment 11.

Receiver.—The receiving apparatus (Fig. 5) consists of a shaft actuated by an electric motor and three stationary contact disks, C_1, C_2, C_3, upon which slide various contact arms secured to the shaft. At the end of the shaft is the character disk, *D*, represented diagrammatically in Fig. 6. This disk moves between a photographic ribbon, *R*, and a small spark gap, *E*. As soon as, through the revolution of the disk, the letter corresponding to the two current impulses is exactly between the ribbon and the spark gap, the electric spark produced at the receiving station by the current impulses jumps and projects the image of the letter upon the photographic paper. Since the character disk has a speed of 33 revolutions a second, the electric spark must jump at the precise moment. As a general thing, it requires a precision of 1/40,000 of a second, seeing that an inaccuracy of 1/4,000 of a second would surely produce a false sign.

The photographic reproduction is obtained in the camera *N* (Fig. 5), in which moves the character disk (Fig. 7). The sensitized ribbon afterward passes into a dark chamber, *F*, under sponges saturated with developing and fixing liquids, and afterward into a dryer. After this, it makes its exit from the apparatus with a reproduction of the telegram printed on it. The box, *L*, contains the liquids necessary for the photographic operation.

The production of the electric spark at the opportune moment is obtained by the three contact disks C_1, C_2, C_3, connected with different condensers and relays. These three disks are, according to the purpose for which they are designed, designated as charge disk, discharge disk, and junction disk (Fig. 4). The first of these comprises 12 segments insulated from one another, and nine of which are connected to a 1-microfarad group condenser. The contact arm, *A*, of the charge disk is in connection with the left contact, 1, of the polarized line relay. To the tongue, *T*, of the armature of this relay is secured a wire that leads to a 2-microfarad high-tension condenser, which receives a charge of 110 volts before the beginning of each new revolution.

When there is synchronism between the transmitting and receiving rotary systems, the contact arm of the transmitting disk, on the occurrence of the first reversal of current of the combination 2/8 of the letter *r*, has just passed from segment 2 to segment 3. Th

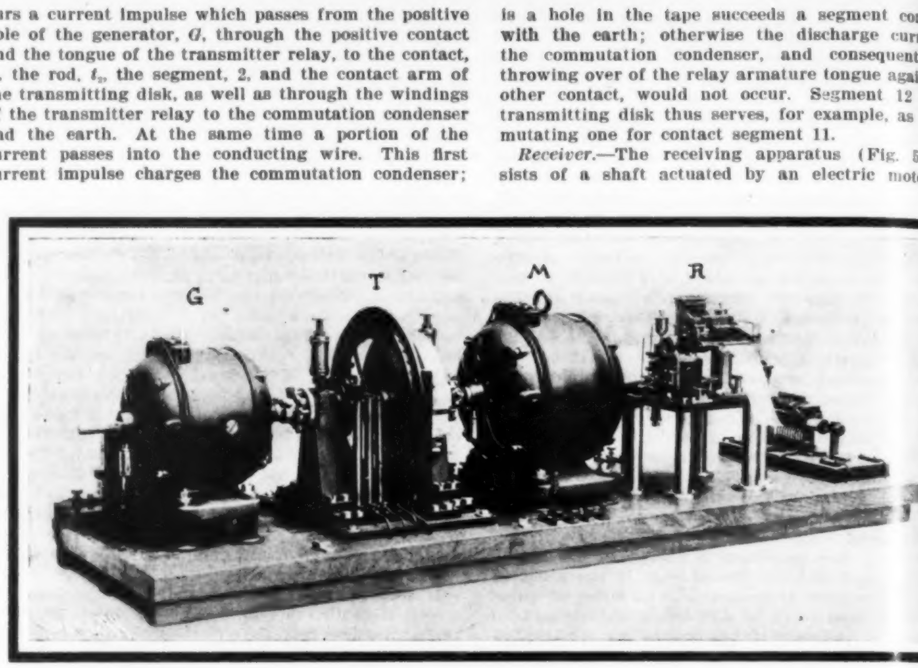


Fig. 3.—Automatic Transmitting Apparatus.

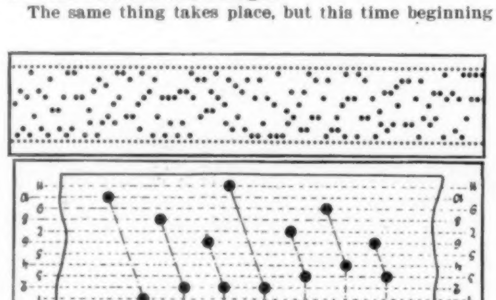


Fig. 2.—Perforated Tape, Showing the Conventional Signs, Each Formed of Two Apertures; the Signs are Simultaneously Printed in Ordinary Characters on the Upper Edge of the Tape.

* Specially prepared for the Scientific American Supplement.

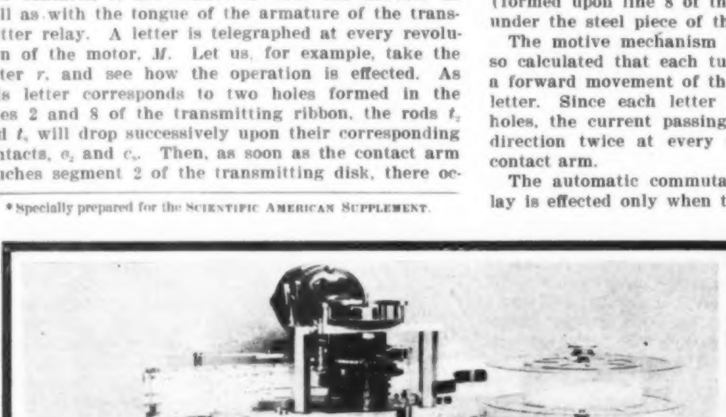


Fig. 1.—Perforating Apparatus.

Fig. 7.—End View of Apparatus, Showing Character Disk, D, which is Inclosed in the Camera, N, of Fig. 5.

contact arm of the charge disk is then between the contact segments I and II. Since upon the passage of the first current impulse the tongue of the line relay is thrown to the left upon contact, 1, and the contact arm then touches segment II, the high-tension condenser discharges itself into the condenser group II.

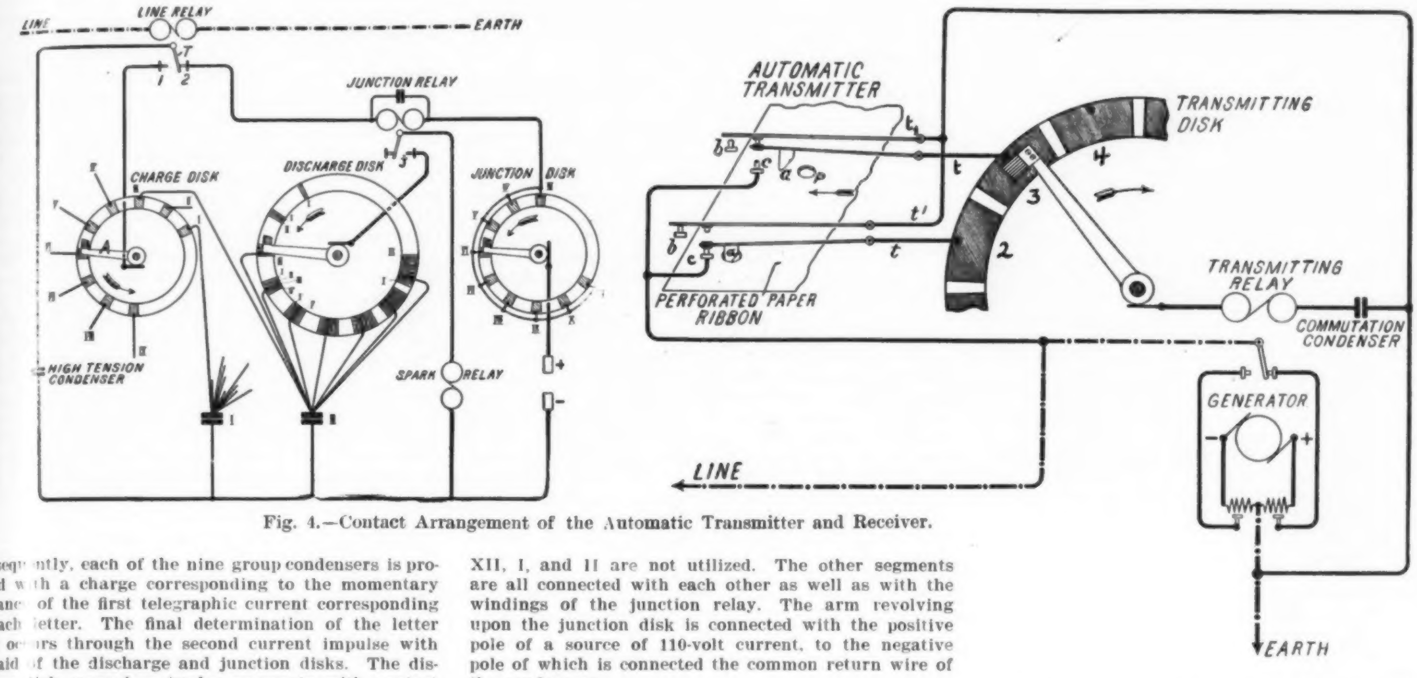


Fig. 4.—Contact Arrangement of the Automatic Transmitter and Receiver.

Consequently, each of the nine group condensers is provided with a charge corresponding to the momentary entrance of the first telegraphic current corresponding to each letter. The final determination of the letter then occurs through the second current impulse with the aid of the discharge and junction disks. The discharge disk comprises twelve segments with contact groups. Segments XII, I, and II are not utilized. The third segment comprises a short insulated contact piece, the fourth two pieces, and so on up to segment XI, which comprises nine contact pieces. The contact pieces of the same number are all connected with one another and with their corresponding group condenser.

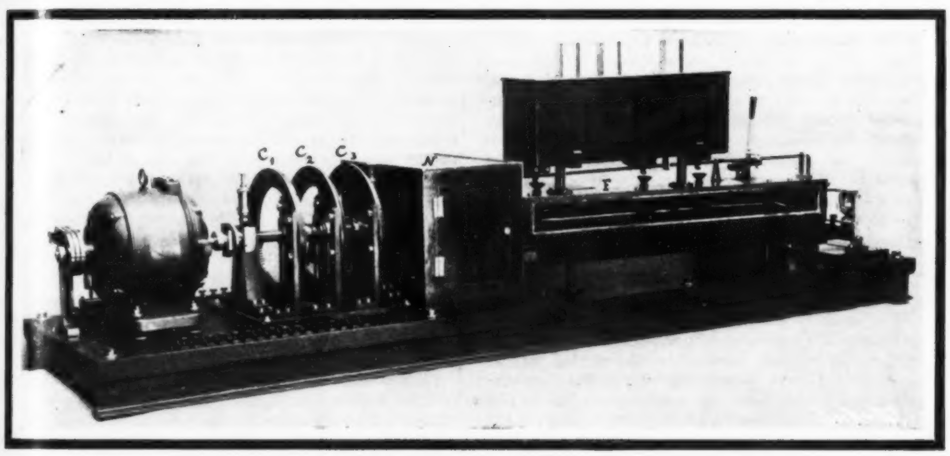


Fig. 5.—Receiving Apparatus.

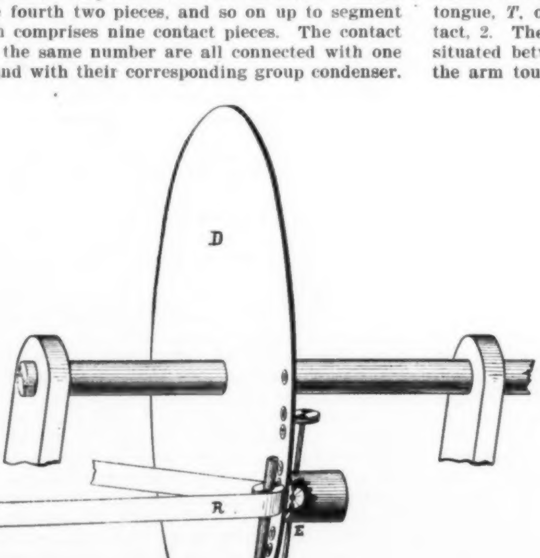


Fig. 6.—Character Disk, Revolving Between the Spark Gap and the Photographic Tape.

The group condenser II, charged by the first current impulse of the letter *r*, will then be able, upon continuing to revolve, to transmit its charge to eight different places of the discharge disk. For this purpose it is necessary that the contact switch, *j*, of the junction relay shall be closed. In order to reach the desired letter, the closing of this switch should take place exactly at the moment at which the contact arm of the discharge disk passes from one group of contacts to the following. The junction disk assures the closing of the switch at *j* at the proper time. This disk comprises likewise twelve small segments of which XII, I, and II are not utilized. The other segments are all connected with each other as well as with the windings of the junction relay. The arm revolving upon the junction disk is connected with the positive pole of a source of 110-volt current, to the negative pole of which is connected the common return wire of the condensers.

The second current impulse of the letter *r* intervenes during 8/12 of the revolution. It moves the tongue, *T*, of the line relay onto the right-hand contact, 2. The contact arm of the junction disk is then situated between segments VII and VIII. As soon as the arm touches segment VIII, a current passes from the positive pole of the 110-volt current source through the contact arm, segment VIII of the junction disk, the windings of the junction relay, the contact, 2, and the tongue, *T*, of the line relay to the high-tension condenser and through the common return wire to the negative pole. The result is that the high-tension condenser is again charged, and that the switch of the junction relay is closed at the same time by the charging current. At this moment, the contact arm of the discharge disk is precisely in the transmitting position between groups VII and VIII. As soon as, through the continuation of its revolution, this arm passes the second contact piece of this group, the condenser, II, is capable of discharging. The discharge current flows through the contact, *j*, and the windings of the spark relay, and the latter produces the electric spark necessary for the illumination of the letter. It is therefore very clear that the arrangement of the characters upon the character disk (Fig. 8) should correspond to that of the contact groups upon the discharge disk. The spark relay which gives rise to the electric spark is a polarized one with two separate windings. The discharge currents flow from the group condensers through the primary winding shown in Fig. 9. The secondary winding is connected on one side with a short contact piece of the spark disk, and, on the other, with the positive pole of the 110-volt current source. The contact arm revolving upon the spark disk is fixed upon the main shaft of the receiving system. As soon as it gets beyond the short contact piece of the spark disk, the spark condenser is charged to 110 volts, and, at the same time, the armature tongue, *A*, of the spark relay is placed at the upper contact. This charging of the spark condenser takes place at every revolution, precisely when the contact arm of the discharge disk passes the non-utilized segments XII, I and II. When the discharge current of one of the nine group condensers passes through the winding of the spark relay, the armature tongue of the latter moves to the lower contact. The spark condenser then discharges through the primary winding of a small induction coil and thus causes a spark to jump the gap in the secondary circuit. The illuminating power of this spark is reinforced by the mounting of a Leyden jar in parallel, as shown.

In order that the Siemens & Halske telecryptograph may operate properly, there must be a constant synchronism between the transmitting and receiving systems. It would take too long to describe in this place the means employed for obtaining and maintaining such synchronous motion, and we shall confine ourselves to a few words concerning the principle applied. Upon the charge disk (Fig. 4) there moves,

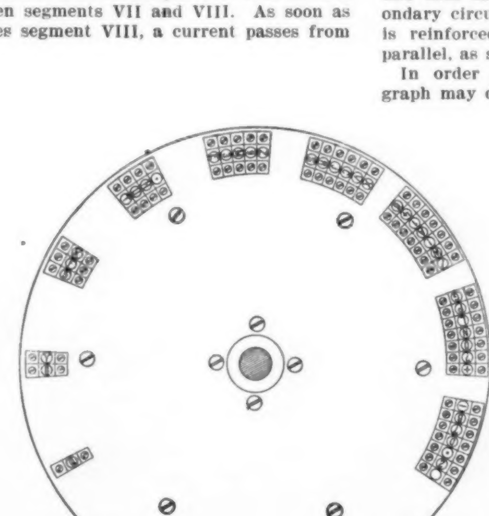


Fig. 8.—Arrangement of the Letters on the Character Disk.

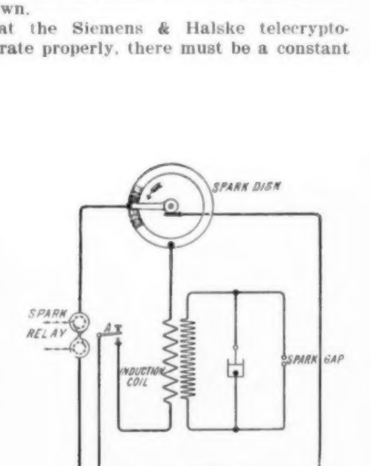


Fig. 9.—The Spark Relay.

not a single contact arm, but three arms. When the synchronism is perfect, the current impulses coming from the high-tension condenser must pass into the group condensers through the central contact arm. When the receiver is forward or backward upon the transmitter the current impulse passes, according to circumstances, through the first or the third contact arm of the contact disk, and then puts into or out of circuit a small regulating resistance in the circuit of the armature of the motor by means of a regulating relay of special construction. Owing to this arrangement, the slight deviations in the running of the apparatus are compensated for at every revolution. For the compensation of great differences in the speed (as may happen when the windings of the motor become heated, or when there is a variation of voltage or friction resistances in the line), an automatic regulator is connected in shunt with the motor of the receiver, and is actuated by a small auxiliary motor.

As soon as the synchronism ceases, a signal bell rings automatically in the receiving office, and an employe shuts off the current by pressing a Morse key. This is to cause an alarm bell to ring in the transmitting office and immediately stops the paper ribbon of the manipulator. In order to regulate the speed of the apparatus and bring it again into synchronism, an employe at the transmitting office repeats the constant current combination of a single letter until the latter registers properly upon the photographic ribbon of the receiving apparatus.

In order to permit Messrs. Siemens & Halske to make practical trials of their new system of telegraphy, the German government has put at their disposal a bronze wire line of 3 millimeters (0.118 inch) diameter and of a length of 600 kilometers (372 miles) between Berlin and Frankfort-on-the-Main. The experiments that have already been made upon this line demonstrate the fact that with this new system it is possible to telegraph correctly an average of 2,000 words per minute in the same direction. It should be noted that, in these experiments, but a single line wire was used, the earth having served for the return current.

DEVELOPMENTS IN MEANS OF COMMUNICATION BY SEA DURING THE NINETEENTH CENTURY.

THE fifth of the centenary series of lectures, under the auspices of the Royal Philosophical Society of Glasgow, was delivered in April last by Mr. Robert Caird, LL.D. Dr. Caird took the above-mentioned subject for his address. He said that in reviewing the progress made during the nineteenth century in the means of communication by sea, we have not, especially in presence of a lay or popular audience, the same opportunities of exciting surprise that the representatives of chemistry and physics have had. Ships, whether sailing or steam, are, and have always been, so interwoven into the daily life and interest of the people of these isles, that there is practically nothing to be said of them which is not perfectly well known, perfectly familiar. Many thousands of our population are engaged in the construction of them, many thousands more in the manning and loading of them, and there is probably no member of the empire who has not had occasion to use them in the transport of himself and his goods. There are, of course, many technical points in connection with these ships—many applications of science—that are accepted and taken for granted, but which are by no means obvious, and only implicitly recognized. Just as in the instinctive movements of the muscles in locomotion, we accept the results, unquestioningly indifferent to, and, therefore, unperplexed by, the physiological problems involved in them.

As, too, gravitation force, that greatest and most impenetrable of the mysteries in the world of physics, has become degraded in our experience into a mere measure of weight until we have ceased to wonder at it, even to respect and acknowledge it. So that perhaps the only way to reawaken the sense of wonder is to recall the difficulties that have been overcome, and the slow and painful nature of the steps that have had to be taken in overcoming them.

The period under review is practically the nineteenth century—more exactly from 1802 till 1902—covering the first hundred years of the existence of this Society—coincident as nearly as possible with the first century of steam navigation. For when this society was founded here in November, 1802, Symington's "Charlotte Dundas" was laid up a few miles away at Lock 16 of the Forth and Clyde Canal, after having successfully demonstrated the power of steam to tow a couple of laden sloops of about 70 tons at a speed of 5 to 6 miles an hour.

It is unnecessary to point out that the application of steam power to propulsion was a direct result of Watt's discoveries and improvements on the steam engine. Earlier attempts on other lines by Symington himself were hopeless failures. The eminently simple direct-acting horizontal engine of the "Charlotte Dundas" embodied at least three of Watt's epoch-making mechanical improvements—the closed cylinder, the separate condenser, and the conversion of reciprocating into rotary motion by means of the crank and connecting rod.

This last, really Murdock's adaptation, was not considered patentable by Watt, who looked upon it as one of the oldest mechanical applications in existence; as he himself said, "The true inventor of the crank rotative motion was the man who first contrived the common foot lathe." However, it was patented by Pickard, by an act of piracy, if we are to credit the biographers, and Watt, in his pride as an inventor, and to retain control of every part of his engine, substituted for this, simplest of devices, his ingenious, if complicated and cumbersome, sun and planet motion. His original intention was, however, undoubtedly to use the crank, so that there is no historical inaccuracy in attributing its adoption in steam engines to his initiative.

The "Charlotte Dundas," having served the purpose of a demonstration of the practicability of the use of steam as a motive power, became an object lesson to enthusiasts, chief among whom were Robert Fulton and Henry Bell.

The first is known to fame in connection with the "Clermont," a vessel of considerable size, some 130 feet long, propelled by an engine of 18 horse-power made by Messrs. Boulton & Watt. This steamer, built in 1807, did regular service on the Hudson River, and may fairly claim to be the first really practical adaptation of steam to marine propulsion, although that claim might have been disputed had the owners of the little "Charlotte Dundas" been enterprising enough to take her out of the canal and venture upon the navigation of the Clyde.

Nearly ten years elapsed before a second attempt was made in Scotland, so slow was the growth of conviction on the part of practical men as to the real value of the new method of propulsion. This caution is remarkable in view of the enormous extension of the use of steam engines for land purposes during the decade of distrust. It may have been due in some measure to Watt's own reluctance to embark on new ventures, and to the opinion he had expressed "that there may be considerable difficulty in making a steam engine to work regularly in the open sea, on account of the undulating motion of the vessel affecting the *vis inertiæ* of the matter." The attempt of Henry Bell proved the real starting point of the great industry of marine engineering on the Clyde. In 1812 he had the "Comet" built for him by Messrs. Wood, of Port Glasgow. She was a tiny craft of 24 tons burden, measuring 42 feet long by 11 feet beam, and drawing 5.6 feet of water. Her engines, or at any rate the forged parts of them, were made at Greenock by Messrs. Anderson & Campbell. Her engine was of three horse-power with a cylinder of 12½ inches diameter, and she is said to have steamed at the rate of five miles an hour, under favorable circumstances.

The introduction of elaborate series of statistical figures into such a paper as this would be manifestly improper, and destroy any interest it might possess. But to illustrate the century's progress, it may be permissible in one or two cases to make a comparison of the dimensions of representative steamships at the beginning and end of the epoch.

It may be objected that it is scarcely fair to take the "Comet" as a basis of comparison, at any rate for size, because, of course, there were then afloat many sailing vessels of much greater tonnage. Indeed, when the nineteenth century opened, the average tonnage of the 18,000 sailing ships of the mercantile marine of the United Kingdom and her colonies was nearly 100, or four times that of the "Comet," some of the largest measuring from 1,300 to 1,400 tons. If, however, steam vessels alone are considered, and our survey limited to this country, the objection falls.

For that purpose the "Comet" has been chosen at the low end of the scale, and she may fairly be compared with such a steamer as the "Baltic," the largest vessel under construction at the date of our centenary celebrations, to mark the extreme limits of the development in steam navigation from the point of view of size of vessels. The "Baltic" is 725 feet long, 75 feet beam, and 49 feet deep, and measures 24,000 tons gross. Her cargo capacity is 28,000 tons, and her displacement at load draft 40,000 tons. The speed for which she is designed is from 16½ to 17 knots, and to propel her at which she is fitted with two sets of quadruple-expansion engines developing 13,000 indicated horse-power and weighing about 2,600 tons.

This huge vessel is thus seen to be in comparison with the "Comet," one thousand times larger, four thousand times more powerful, and three and a half times faster, while the "Kaiser Wilhelm II." has fifteen thousand times the power of the "Comet," and steams five times faster. Surely so great an advance is worthy of the wonderful century that has gone.

It implies a continuous activity and progressive development in the arts which contributed to the construction and equipment of steam vessels and their machinery, an alert recognition of the ever-changing conditions which each fresh step imposed, and a sublime courage in sacrificing whole fleets obsolescent before pride in them had had time to cool.

The Atlantic ferry has naturally been the scene of the greatest developments in maritime transport. The first steamship to cross the Atlantic was the "Savannah," a wooden vessel of 320 tons—built in America. Her steam power was merely auxiliary, the paddles being shipped and unshipped—indeed on the passage of 29 days 11 hours from Savannah to Liverpool in 1819, steam was only used for three days.

The first vessel to steam all the way across was the "Royal William," of 830 tons, in 1833, with side lever engines of 200 nominal horse-power, by Messrs. Boulton & Watt. She took 38 days to cross from Quebec to London at a time when sailing ships were making the passage in from 17 to 22 days. It is impossible to overrate the courage and enterprise of the pioneers of this service in the face of the difficulties and discouragements they had to encounter—difficulties arising not only from perils of the sea and the crude nature of the apparatus at their command, but also from the skepticism of contemporaries, even of learned scientists. You remember Dr. Lardner's famous, if rash, prediction in 18[illegible] "as to the project, however, which was announced in the newspapers lately, i. e., of making the voyage directly under steam between New York and Liverpool, it was, he had no hesitation in saying, perfectly chimerical, and they might as well talk about making a voyage from New York or Liverpool to the moon."

His calculation was based upon an estimate of the fuel required on so long a passage, and the inability of vessels of ordinary dimensions to carry it.

Within three years, however, the "Sirius" and "Great Western," generally considered the pioneers of the Atlantic steam service, successfully accomplished the supposed impossible feat, and reduced the passage from 17 to 13½ days. They were wooden paddle steamers with side lever engines of what may be called the land type, and consumed respectively 24 and 33 tons per day, averaging about 8½ knots. The "Sirius" is remarkable in that she was fitted with Hall's surface-condensers. These vessels inaugurated in 1838 a regular Atlantic service, which has never since been discontinued. This date corresponds closely with that of the classification of the first iron steamer in Lloyd's Register, with the introduction of the screw propeller, and with the founding of the Peninsular and Oriental Company, all in 1837. The change from wood to iron as the principal material of construction in shipbuilding was a most momentous one to us as a nation, for our home supplies of timber were being rapidly exhausted, and America, in virtue of her vast forests of magnificent trees of every variety, was fast gaining upon us in the amount of tonnage turned out annually, and did actually surpass us just before the outbreak of the civil war in 1861. There was in these early days a popular prejudice against iron, because it was considered that it would not float, a prejudice that died hard, and not until the behavior of the "Great Britain" in 1846, after being ashore in Dundrum Bay for nearly a year, demonstrated the capabilities of iron to withstand treatment to which a wooden ship would certainly have succumbed, were even professional shipbuilders converted to a full faith in its usefulness.

Iron had been employed as early as 1788 in the construction of barges for the Severn by John Wilkinson, who made all Watt's castings for him before the opening of the Soho Foundry, and several vessels were built of it before 1837. Its introduction was, however, slow, as may be seen from the fact that no rules were formulated regulating iron scantlings by Lloyd's Register until 1854 and then the preface opened with the significant words: "Considering that iron shipbuilding is yet in its infancy." It was a tolerably vigorous infancy which included such vessels as the "Great Britain" and the "Atrato," and was already engaged on the design of the "Great Eastern." The first steamers of the Cunard Company, which began operations in 1840, were built of wood, the last of this material being the "Arabia" in 1852, of 2,400 tons and 2,900 indicated horse-power. The first iron vessel of this great company which, since 1840, has maintained an uninterrupted service across the Atlantic, was the "Persia," built in 1855.

Last winter the Cunard Company issued a handbook for the use of passengers containing *inter alia* a very compact diagram showing the growth in size and power of the vessels of their fleet. Twenty-nine representative steamers are shown to scale, grouped according to material of construction and means of propulsion. Wooden vessels, from 1840 to 1852, and from 220 to 280 feet long, were all paddle steamers, steaming from 8½ to 13 knots; of a gross tonnage of 1,154 to 2,400 tons, and an indicated horse-power of 740 to 3,250.

The era of iron inaugurates much greater size. It extends from 1855 to 1879, shows a slight increase in length, from 376 to 430 feet, but the *first* iron ship was nearly 100 feet longer than the *last* wooden one. When paddles were replaced by screw propellers in 1862, the length was reduced by about 50 feet, and then gradually increased in successive ships; tonnage increased from 3,300 to 4,800; horse-power from 4,000 to 5,300; and speeds from 13.8 to 15½ knots.

From 1880 onward Siemens-Martin, or what is called mild steel, has taken the place of iron, and the steamers of this company have increased in length from 515 feet in the "Servia" to 600 in the famous "Campania" and "Lucania," and since 1890 the single screw has given place to the twin; tonnage has risen from 7,400 to 13,000; horse power from 9,900 to 26,000; and speed from 16.7 to 22 knots. These figures may be taken as representing pretty fairly the general practice of the greater companies.

The Cunard has not always held the blue ribbon for size or speed even in this country. It had to yield the palm to the Collins Line, the Inman, White Star, and Guion lines successively; but it has never retired from the competition, and periodically takes its place in the van. While, therefore, the official diagram must not be taken strictly as an indication of the earliest adoption of the leading features in the progress of steamship design, or always of the greatest advance in size or power at any given time, it presents a broad view of the gradual growth of British shipping of the highest class. The most striking feature in the progress thus shown is that the passage from New York to Liverpool is now made in little more than one-third of the time occupied in 1840, and that the time saving is accompanied by an increase in tonnage of twelve times, and in power of thirty-five times. Had the tonnage not been increased the power for 22 knots would only *ceteris paribus* have been fourteen times that necessary for 9 knots. But for the improvements in marine engineering the "Campania" would require 2,450 tons of coal per day instead of about 450—that is to say,

e would consume as much in one day as she now does the whole trip.

Perhaps the most wonderful instance of engineering ill, considering all the circumstances of the knowl- ge then in existence of the properties of iron—of pre- dent in the matter of size and power—is afforded by e "Great Eastern." In his presidential address to e Institution of Civil Engineers at the opening of is session, Sir Wm. White made a most appreciative ference to the genius and skill of Brunel and Scott ussell, her designer and builder respectively, and ade a comparison between this great ship and some the most recent vessels of similar size, from the int of view of structural weight and strength, which annot but increase our admiration for the foresight d ability of these pioneers in iron shipbuilding. runel began to consider the question of a steamer to rry her own coal out and home on an Australian voy- e at a high rate of speed in 1851. Two years later rangements were made for her construction. At that me the largest iron steamers were the "Himalaya" the P. & O. Company and the "Atrato" of the Royal ail Co.—the first 340 feet long, 3,400 tons gross, 4,000 ns displacement, with 2,000 horse-power, and 12 ots speed; the "Atrato" 315 feet long, 3,460 tons oss, 4,000 horse-power, and 13½ knots speed.

The boldness of Brunel's achievement may be realized hen we consider that he designed and built the "Great astern" of double the length of the longest then exist- g steamer, of five times the tonnage, and twice the wer. The "Himalaya" was then "too large for the mmercial work of that day," as Sir Thomas Suther- nd tells us. What would be thought to-day were a ipbuilder to propose to build a steamer greater than, y, the "Kaiser Wilhelm II." in these ratios?

The "Great Eastern's" particulars were as follows: ngth, 680 feet; breadth, 83 feet; depth, 58 feet; ton- ge, 19,000 nearly (gross); displacement, 30,000 tons 30 feet draft, 32,700 tons on 34½ feet draft (when hile laying in 1870). Her power was about 8,000 in- cated. Nearly half a century elapsed before vessels greater size and tonnage were built. Her power was velope as to 60 per cent in screw and as to 40 per nt in paddle engines, and the speed at sea was prac- ally that aimed at by her designer—14 knots. Sir m. White has drawn attention to some of Brunel's atements which are well worth preservation. "The e of iron," he remarks, "removes all difficulty in the nstruction, and experience of several years has proved at size in a ship is an element of speed, strength, d safety, and of greater relative economy, instead a disadvantage, and that it is limited only by the tent of demand for freight, and by the circumstances the ports to be frequented."

It is a most interesting thing that from a technical int of view, the problem was completely and success- lly solved notwithstanding the disastrous character the speculation commercially.

I abstract the following from Sir Wm. White's paper corroboration: "Having carefully looked into the atter in the light of present knowledge, I am of opin- n that the estimate of power required to drive the reat Eastern' at 14 knots, with an average draft of bout 25 feet, is practically identical with that which ould now be made for the ship if propelled by twin rews." And further: "As to strength, the vessel was verely tested during the thirty-two years she remain- d afloat. She carried enormous loads of submarine bles, encountered very severe weather, ran on the cks off Montauk Point, and tore a hole in the outer in 80 feet long by 10 feet broad, but proceeded to ew York, her passengers being unaware of the dam- ge done. She was repeatedly beached on a 'gridiron' the Mersey and at Milford Haven for repairs; yet roughout this service no signs whatever of struc- ral weakness occurred, and local damage was readily ade good." And lastly, on the question of relative eight: "I have most thoroughly investigated the estion of the weight absorbed in the structure of the reat Eastern,' and my conclusion is that it is con- derably less than that of steel-built ships of approxi- ately the same dimensions and of the most recent nstruction. Of course, these vessels are much faster, ve more powerful engines, and have superstructures r passenger accommodation towering above the true per decks which form the upper flanges of the gir- rs. These and other features I cannot now specify volve much additional weight, and the 'Great East- n' has the advantage of being deeper in relation to r length than the modern ships. After making full lowance for these differences, my conclusion is that e 'Great Eastern' was a relatively lighter structure, lthough at the time she was built only iron plates of ry moderate size were available." Brunel found him- elf hampered by established practice and expressed is belief, one shared by many a designer since his ay, "that we should get on much quicker if we had o previous habits or prejudices on the subject."

(To be concluded.)

Physiological N-ray Observations.—A. Broca gives ome practical instructions with regard to the N-ray xamination of the human body. The best screen to se for the purpose is made by attaching a wooden topper to a leaden tube about 5 centimeters long, ipping it into a very dilute collodion solution, watching a cross on it, filling the cross with the owdered sulphide and covering the latter with a thin layer of collodion. The screen should be excited y diffused daylight. On taking the screen over the urface of the skull, it is found that it remains dark- nt along certain lines which are found to coincide with the sutures. This may be explained by the cir- cumstance that at the junctions of the cranial bones the active convolutions are necessarily furthest from the screen. The tube should be moved by the ob- server, and not by a second person.—A. Broca, Comptes Rendus, May 9, 1904.

MIRROR SILVERING, A METHOD OF SECURING A THICK AND DRY DEPOSIT.

In the Process Photogram for October, 1903, Dr. Miethe emphasizes the fact that large prisms cause great loss of light, and, in addition, affect the sharpness of the image. The loss of definition is not so notice- able when the lens is being used upon copies to be con- siderably reduced, and, consequently, with short exten- sion of bellows; but when a lens of say 20 inches equiv- alent focus is being worked at an actual focus of, say, 35 to 40 inches, the effect of striæ within the great bulk of glass means an absolute impossibility to secure that crispness so essential to 90 per cent of commercial reproduction. And, mark, if there be this defect of unequal density within any prism (not easily discov- erable even after some use) the definition is bound to be impaired, be the "figuring" of the three surfaces never so perfectly finished. And, since the same emi- nent authority expresses the opinion that modern lenses (anastigmats, especially those of wide angle) should only be used with mirrors, when reversing, I shall not be thought old-fashioned in giving the routine of mir- ror-making which my firm has adopted during the past nine years.

The basis-formula of the following instructions is of considerable age, but appears to have been kept well out of sight, for some reason; perhaps its simplicity ac- counts for its obscurity. The details of applying it are innovations of my own, and result in a clean and bril- liant coating of silver which may be built to such a thickness as to be quite opaque if desired. Mirrors coated in this way last longer than those by the univer- sally known methods in which a deliquescent salt is used in reducing the silver, and, moreover, withstand considerably more polishing—to such an extent that the very particular person would be justified in keep- ing my "dry" mirror in use for at least a couple of months, while the unparticular operator would not blush for his negatives even after ten months' use of it, though the comfortable mean lies, of course, some- where between the two.

Procedure.—Place the old mirror into a weak solu- tion of nitric acid—say 5 per cent—which immediately removes the silver. Rinse it a little, and then clean very thoroughly with a pledget of cotton-wool and a mixture of whiting and ammonia. Rouge will answer in place of whiting, or, as a last extreme, finest levi- gated pumice, first applied to a waste glass to crush down any possible grit. This cleaning is of the very utmost importance, as upon its thoroughness depends eventual success. Front, back, and edges must alike be left in a state above suspicion. The plate is then again flowed with weak acid, rinsed under the tap, then flowed back and front with distilled water, and kept immersed in a glass-covered dish of distilled water until the solutions are ready.

The depositing vessel is the next consideration, and it should be realized that unless most of the silver in the solution finds its way on to the face of the mirror it were cheaper that the glass should be sent to the professional mirror-maker. The best plan is to use a glass dish allowing of 1-16 inch margin all round the mirror, inside. But such a glass dish is expensive, having to be made specially, there being no regular sizes near enough to 4 x 7 or 8 x 5 (usual mirror sizes). If too large a dish must perforce be used, the sides or ends should be filled up with sealing-wax. Four strips of glass are temporarily bound together with two or three turns of string so as to form a hol- low square. The side pieces are ¼ inch longer outside and the end pieces ¼ inch wider than the mirror glass. This frame is placed in about the center of the dish, moistened with glycerine, and the molten wax flowed outside of it to a depth of about three-quarters of an inch or more. For economy's sake, good "parcel wax" may be used, but best red sealing is safer. This wax frame may be used repeatedly, being cleaned prior to each silvering operation. It is the only special appli- ance necessary, and half an hour is a liberal time al- lowance for making it.

A PROCESS FOR COPYING PRINTED PICTURES.

The so-called "metallic" paper used for steam-engine indicator cards is familiar to all mechanical engineers. It has a smooth surface, chemically prepared so that black lines can be drawn upon it with pencils made of brass, copper, silver, aluminium, or any of the softer metals. When used on the indicator, it receives the faint line drawn by a brass point at one end of the pencil arm, and its special advantage over ordinary paper is that the metallic pencil slides over its surface with very little friction, and keeps its point much longer than a graphite pencil.

Another property, not generally known, is possessed by this paper, and may possibly render it of great value for a purpose quite different from that for which it is now manufactured. It can be used as a transfer paper for copying engravings or sketches, or in fact anything printed or written in ink or drawn in pencil. If a sheet of it is laid face downward upon a printed pic- ture, and then rubbed hard upon the back with a blunt- pointed instrument, such as the rounded end of a pocket knife handle or a smooth piece of ivory, a copy of the original picture will be transferred to the indicator paper. The copy is produced by removal of ink from the print, but the amount removed, although enough to make fairly dark lines, is so small that the original is left practically uninjured and nearly as dark as be- fore. Firm pressure of the tool is necessary, but pres- sure alone will not effect the transfer; abrasion of the ink surface is necessary, and it is secured by the very slight slipping of one sheet over the other, caused by local stretching of the paper under the point of the rubbing tool. Any more than minute, local slipping must of course be prevented, or a blurred copy will result. The transfer paper should be protected by a thin piece of cardboard laid over it, and the two should be held tightly under the thumb and forefinger of the left hand while the tool is rubbed all over the card- board, from side to side and top to bottom. Less than a minute is sufficient time for transferring a cut from 2 inches to 2½ inches square; larger ones require longer time and the exercise of care to prevent stretching and consequent distortion, the difficulties becoming so great that the process seems at present limited to pictures not over 4 inches square. A corner of the transfer paper may be turned up for examination at any time.

Line drawings printed from relief plates, or pictures with sharp contrast of black and white without any half-tones, give the best copies. Very few half-tones can be transferred satisfactorily; almost all give streaked, indistinct copies and many of the results are worthless. This process is not recommended for copy- ing half-tones.

The transfer taken off as described is a reverse of the original print, "a view of the opposite hand," as draftsmen say, and any lettering on it will read back- ward. If the question of right and left is not import- ant, this reversal will seldom be objectionable, for it is easy to read backward what few letters generally oc- cur. However, if desired, the paper may be held up to the light and examined from the back, or placed before a mirror and viewed by means of its reflected image, when the true relations of right and left will be seen. Moreover, if sufficiently important, an exact counter- part of the original may be taken from the reversed copy by laying another sheet face downward upon it and rubbing on the back of the fresh sheet just as was done in making the reversed copy. The impression thus produced will be fainter than the first, but almost always it can be made dark enough to show a distinct outline which may afterward be retouched with a lead pencil.

For indicator cards, the paper is prepared by coating one surface with a suitable compound, usually zinc ox- ide mixed with a little starch and enough glue to make it adhere. After drying, it is passed between calender rolls under great pressure. The various brands manu- factured for the trade, though perhaps equally good for indicator diagrams, are not equally well suited for copying. If paper of firmer texture could be prepared with the same surface finish, probably much larger copies could be produced.

Other kinds of paper, notably the heavy plate papers used for some of the best trade catalogues, possess this transfer property to a slight degree, though they will not receive marks from a metallic pencil. The latter feature would seem to recommend them for transfer purposes, making them less likely to become soiled by contact with metallic objects, but so far no kind has been found which will remove enough ink to give copies anywhere near as dark as the indicator paper.

In choosing pictures for illustration, the writer se- lected those which could be copied with best results. Fairly good transfers can be made from almost any common printer's ink, but some inks copy much better than others, and some yield only the faintest impres- sions. The length of time since a picture was printed does not seem to determine its copying quality. Some very old prints can be copied better than new ones; in fact, it was by accidental transfer to an indicator card from a book nearly a hundred years old that the peculiar property of this "metallic" paper was discov- ered.

The reader has probably noticed, in examining old books, that reversed impressions of engravings are of- ten found on the fly leaves or tissue sheets which face them. This is probably due to chemical action between the ink and the paper; it is not the result of a physical transfer, for usually the ink was dry before the book was bound, and since that time it has not been sub- jected either to friction or to great pressure.

How many draftsmen and engineers have often want- ed private copies, however faint or imperfect, of small details which were too complicated to remember, and which would require too long to trace; how often per- sons reading in any branch of science would like to make copies of pictures or diagrams from books which they cannot buy, or which are too cumbersome to have at hand when wanted. A ready means of supplying such demands with exact copies of the originals, how- ever intricate, is afforded in this frictional transfer process. For small copies the results are already very satisfactory, and it is believed that by improvement the process can be made of value for work of a much more pretentious character.

Since the above was written, it has been found that much better copies can be made by following the direc- tions below, instead of those already given: Lay the metallic transfer paper, face up, upon at least a dozen sheets of blank paper, and lay the print face down upon it. On the back of the print, place a sheet of heavy paper, or thin cardboard, and run the rubbing tool over this protecting sheet. In this manner it is comparatively easy to prevent slipping, and prints eight or ten inches on a side may be copied satisfactorily.— Joseph C. Riley, in Machinery.

GERMANY AT THE ST. LOUIS EXPOSITION.

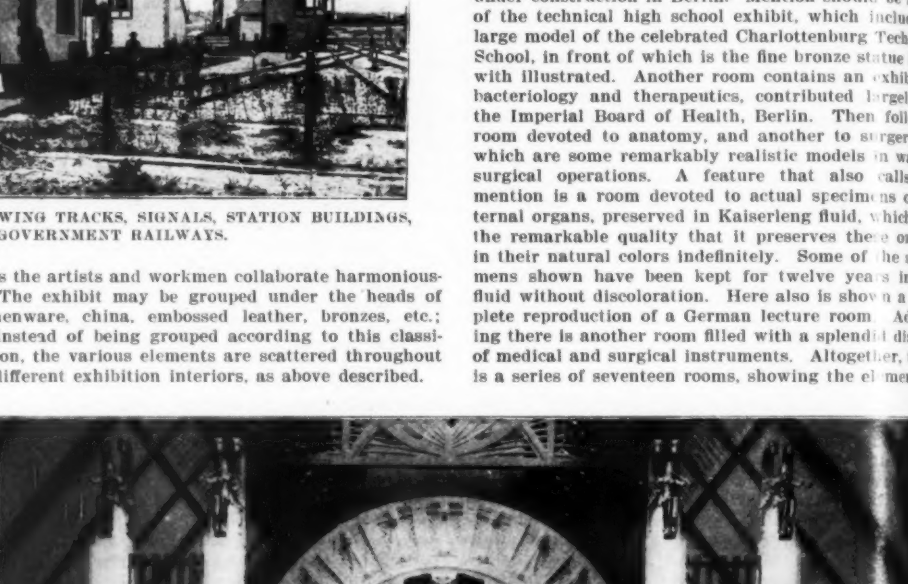
By the St. Louis Correspondent of the SCIENTIFIC AMERICAN.

OF the nations represented at the St. Louis Fair, there is none, with the possible exception of Japan, that is so broadly in evidence as Germany. She is represented in greater or less degree in practically every building of importance, and her pavilion, without doubt the most imposing of the national pavilions, has a most commanding site on the flank of the semicircular hill upon which stand the Festival Hall and Colonnade of States. This last building, which is a reproduction of the Castle of Charlottenburg, forms the subject of an illustrated article in the current issue of the SCIENTIFIC AMERICAN, to which the reader is referred for full particulars.

FULL-SIZE REPRODUCTION OF A GERMAN RAILROAD, SHOWING TRACKS, SIGNALS, STATION BUILDINGS, ETC., AS EXISTING ON THE GERMAN GOVERNMENT RAILWAYS.

The German interests at the Fair are so numerous, and each is so extensive in itself, that it is impossible within the limits of this article to give more than a fragmentary illustration, or even description. The magnitude and very high character of the German effort are due largely to the personal interest of the German Emperor—a fact which is freely acknowledged and, indeed, insisted upon by the various German commissioners and exhibitors that one meets at St. Louis. Indeed, one cannot finish his study of the subject without receiving a fresh impression of the very strong hold which this remarkable man has upon the interest and affection of the German people.

If called upon to select the particular section of the German exhibits that is entitled to hold the first place, we think that the choice should fall upon the display in the Palace of Varied Industries, where a reservation of 80,000 square feet has been devoted almost exclusively to an exhibit of the German arts and crafts. Like every section throughout the Exposition, this one is housed in what might be called a sub-building within the walls of the main Exhibition Building, an arrangement which serves to give to the exhibit at once greater security and more distinct definition. As was to be expected, the "new art" is here very much in evidence. In fact, it dominates the whole display, both in the Exhibition Hall and its various subdivisions. The scheme of arrangement consists of a Court of Honor, of which we present an illustration, around which is arranged a series of studies of interiors, such as bedrooms, dining-rooms, offices, etc. Each of these is the work of a single artist, who designed them in their entirety, including the architectural features of the room itself, the furniture, upholstery, art glass work, and even the chandeliers and gas brackets. It is considered that in this way a more harmonious effect can be secured than by the collaboration of several people. The whole effect is decidedly rich and very creditable; but we think that the result is obtained rather in spite of, than because it is dominated by the new art, which to our thinking can never rid itself of the objection that it does violence to the fundamental principles of construction. Everything in this exhibit is hand-made, and much of its excellence, it is claimed by the commissioner in charge, is due to the fact that in the arts and crafts the artists and workmen collaborate harmoniously. The exhibit may be grouped under the heads of earthenware, china, embossed leather, bronzes, etc.; but instead of being grouped according to this classification, the various elements are scattered throughout the different exhibition interiors, as above described.

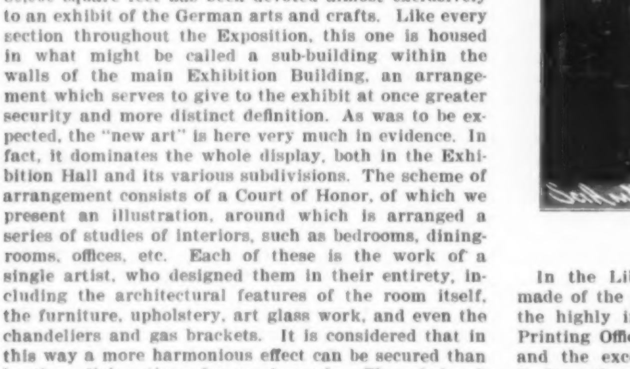


COURT OF HONOR IN THE GERMAN SECTION, PALACE OF VARIED INDUSTRIES.

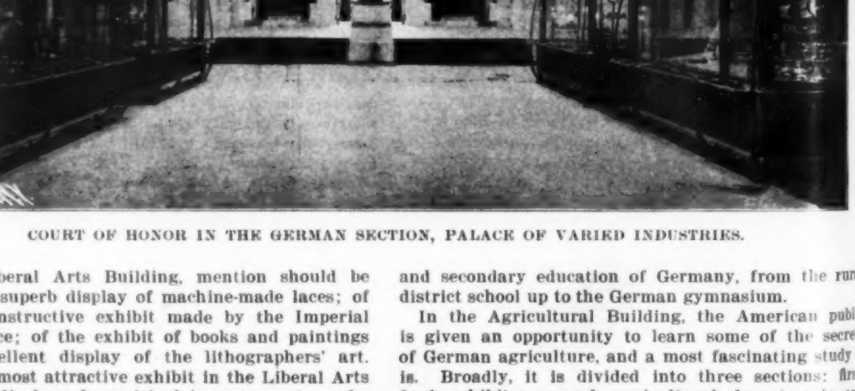
In the Liberal Arts Building, mention should be made of the superb display of machine-made laces; of the highly instructive exhibit made by the Imperial Printing Office; of the exhibit of books and paintings and the excellent display of the lithographers' art. Perhaps the most attractive exhibit in the Liberal Arts is the large display of municipal improvements, a department in which the Germans excel. Here are some really superb models of engineering works, such as bridges, gas works, water works, docks, and the various appliances for river and harbor improvement.

We have heard so much of late years of the excellent character of German educational methods, that the American people naturally have turned with considerable interest to the German educational exhibit in the Educational Building at St. Louis. Like other departments, it has a Court of Honor, in which are found choice selections from leading German scientific libraries. Beyond is a room devoted to an exhibit of the wonderful Roman camp at Saalberg, which consists of models that are exact duplicates of the wonderfully well-preserved specimens that were found. It shows to what a high degree of efficiency the Roman craftsman had attained. The models of the Roman agricultural and carpenters' tools alone are of surpassing interest. In the next room, known as the University Room, is a collection of photographs, maps, and drawings of the modern German universities. Attention is drawn to a fine painting for the new public library now under construction in Berlin. Mention should be made of the technical high school exhibit, which includes a large model of the celebrated Charlottenburg Technical School, in front of which is the fine bronze statue herewith illustrated. Another room contains an exhibit of bacteriology and therapeutics, contributed largely by the Imperial Board of Health, Berlin. Then follows a room devoted to anatomy, and another to surgery, in which are some remarkably realistic models in wax of surgical operations. A feature that also calls for mention is a room devoted to actual specimens of internal organs, preserved in Kaiserleng fluid, which has the remarkable quality that it preserves these organs in their natural colors indefinitely. Some of the specimens shown have been kept for twelve years in the fluid without discoloration. Here also is shown a complete reproduction of a German lecture room. Adjoining there is another room filled with a splendid display of medical and surgical instruments. Altogether, there is a series of seventeen rooms, showing the elementary and secondary education of Germany, from the rural district school up to the German gymnasium.

In the Agricultural Building, the American public is given an opportunity to learn some of the secrets of German agriculture, and a most fascinating study it is. Broadly, it is divided into three sections: first, food exhibits; second, agricultural department; and lastly, colonial exhibits. The food exhibit alone covers



REPRODUCTION OF LABORATORY OF LIEBIG AT ST. LOUIS.



UNIVERSITY ROOM, GERMAN EXHIBIT IN THE EDUCATION BUILDING, ST. LOUIS.

GERMANY AT THE ST. LOUIS EXPOSITION.

15,000 square feet. Here are all varieties and sizes of exhibits of preserves, canned meats, products of the bakery, etc. Of great interest is the exhibit from the Imperial Laboratory for the inspection of foods, against whose stringent provisions some of our exporters recently collided. It is a practical impossibility in Germany to put upon the market adulterated food, so searching is the examination made by the elaborately-equipped laboratories, of which an excellent display is included in this section.

The agricultural section, which was gotten up by the Agricultural Society of Berlin, the leading organization of the kind in Germany, is very complete. The exhibit of the agricultural schools and universities includes a display of apparatus for experimental work in the universities and schools. To many visitors the most popular and picturesque display of all is the exhibit showing the remarkable work done in the recovery of peat lands. The Germans have recovered vast deposits of peat land from their natural state, and brought them into a high state of cultivation. This work is shown by a variety of sectional views, paintings and drawings, among which is a highly instructive sectional view, ten feet in height, of an actual peat bog. There are models showing the method of drainage and the system of foundation work for carrying the farms and buildings by means of special systems of foundations. The exhibit includes a display of special tools, which have been designed for work in peat lands. And here, also, we see a complete display of the products of peat, such as motor oil, paraffine, wagon grease, alcohol, etc., to say nothing of a form of artificial wood.

In the school department, one gathers a new impression of the wonderful skill of the Germans in the manufacture of models for instruction, and one's interest is centered instantly upon some beautiful models of the various breeds of cattle, that are very lifelike both in form and coloring. These include models even of sick animals, from which the student is taught to recognize the various ailments from the external symptoms. Here we see some fine models of the schools in Berlin, and a map showing the location of the various schools. Want of space forbids any detailed reference to the display of the great Agricultural Society, with its wonderful chain of maps showing areas devoted to crops, with its display of two hundred varieties of potatoes arranged in orderly sequence, with its model of the experimental plant station at Berlin, and its system for the study of parasites. The great beet industry of Germany receives, also, adequate representation.

In Germany the government owns the railroads, and a large section of outside ground at St. Louis is devoted to a very complete display of the German government railroad system. This, by the way, is a full-sized display, in which the stations, signals, track switches, etc., are literal reproductions. There is a complete station master's room, from which the whole operation of the station, its yard and signal system, is controlled. There is a model of the station block box, which locks all the signals, so that signalmen cannot operate the switches under their individual control, until they are unlocked by the station master from his central box. An ingenious device is shown for regulating the speed of the trains on sections of the road where engineers are expected to slow down, such as on dangerous curves, approaches to drawbridges, etc. By means of contacts, connected with a clock and a moving tape, the actual speed of each train is automatically recorded. Here also are shown specimens of track with steel ties and with creosoted wood ties, to say nothing of steel rails, switches, frogs, methods of splicing the joints, etc. The interlocking system for signals is shown by a full-sized model and, in fact, there is no important element connected with the state-owned German railroads that cannot be studied in this particular section of the German exhibits.

THE JO-KANG IN LHASA.

THE HOLY OF HOLIES OF BUDDHISM.

It is not always realized that it is in the cathedral of Lhasa, not in the palace outside, that the spiritual life of Tibet and of the countless millions of northern Buddhism is wholly centered. The policy of isolation which has for so long been the chief characteristic of the faith finds its fullest expression in the fanatical jealousy with which this temple, the heart and focus of Lamaism, has been safeguarded against the stranger's intrusion. What Tibet is to the rest of the world, what Lhasa is to Tibet, that the Jo-kang is to Lhasa, and it is not entirely clear, in spite of more than one so-called description of the interior, that any European, or even native spy, has ever before ventured inside. There has, perhaps, been reason enough for this. It is possible that pardon for having visited the city of Lhasa, or the Potala Palace—which is in comparison almost a place of resort—might have been obtained on terms, but there could hardly have been a reprieve for the luckless intruder once discovered inside these darkened and windowless quadrangles. Certainly neither the ground plan published by Giorgi in the eighteenth century nor any of the detailed accounts published more recently suggest that their authors had any first-hand acquaintance with the place.

As I have noticed in a former letter, the exterior is devoid of either beauty or dignity. The interior, on the other hand, is unquestionably the most important and interesting thing in Central Asia. It is the treasure-house and kaabah, not of the country only, but of the faith, and it is curious that, while the magnificent Potala is a casket containing nothing either ancient or specially venerated, the priceless gems of the Jo-kang should be housed in a building which literally has no outside walls at all. All round the cathedral the dirty and insignificant council chambers and offices, in which the affairs of Tibet are debated and administered, lean like parasites against it for support, huddled together and obscuring the sacred structure to which they owe their stability, in a way that seems mischievously significant of the whole state of Tibet.

WOODEN MODEL OF SKULL FOR ANATOMICAL DEMONSTRATION. MEDICAL SECTION OF GERMAN EXHIBIT, EDUCATION BUILDING, ST. LOUIS.

From Chagpori the five great gilded roofs are indeed to be seen blazing in the sun through the tree tops hard by the Yutok Bridge, but even this suggestion of importance vanishes as one treads a way through the filth of the narrow streets to the western entrance. So crowded upon is the Jo-kang that this is actually the only part of the structure which is visible from the street which surrounds it.

It is not strangers only against whom the great doors of the Jo-kang have been barred. Exclusion from its sacred precincts is officially pronounced against those also who have incurred the suspicion, or displeasure, of the ruling hierarchy of Lhasa, and it is a curious proof of the autocratic power which is exercised with regard to this cathedral, as well as of the insignificance of the suzerainty, that on August 11 in this year the Viceroy himself, going in state to the Jo-kang to offer prayer on the occasion of the Chinese Emperor's birthday, had the doors shut in his face. To this insult the opportunity I have enjoyed of examining the temple with a fullness that would otherwise have been impossible was due. Anxious to retaliate, the Amban—who was on a subsequent day grudgingly permitted to visit the ground floor only of the building—used our presence in Lhasa to teach the keepers of the cathedral a lesson in manners. At any rate, to our surprise, a definite invitation was one day extended to one or two of the members of the Mission to make a morning visit into Lhasa for the purpose of examining the treasures of the innermost sanctuary of Buddhism. It was accepted. A Chinese guard of the Residency, armed with tridents, halberds, and scythe-headed lances, provided our escort, and immediately upon our arrival the great doors, half hidden in the shadow under the many-pillared propylon, were opened and at once barred again behind us.

Just in front, seen through a forest of pillars, was an open and verandahed courtyard. Its great age was at once apparent. The paintings on the walls were barely distinguishable through a heavy cloak of dirt and grease, and it was difficult to imagine the colors with which the capitals of the pillars and the raftered roof overhead had originally been painted. The court is open to the sky and is surrounded by none of the small chapels which are the chief feature of the inner quadrangles of the Jo-kang. The architecture is of the kind invariable in religious buildings in Tibet—a double row of pillars carry the half-roof overhead, each supporting on a small capital a large bracketed abacus, voluted and curved on both sides and charged in the center with a panel of archaic carving. The wooden doors which secure both entrances of the first court are of immense size, heavily barred, and embossed with filigree ring plates of great age.

At the opposite end of the court an open door communicates with the second court, revealing a bright mass of hollyhocks, snapdragon, and stocks, vivid in the sun. The sanctity of the temple obviously increased as we ventured into this inner court. Its sides are honeycombed by small dark chambers, apparently built in the thickness of the enormous wall. Each is an idol-crowded sanctuary. Into these obscure shrines one stumbles, bent almost double to avoid the dirt of the low greasy lintel. Once inside, the eye requires some time to distinguish anything more than the dim outlines of an altar in the middle of the chamber. On it stand one or two copper or brass bowls filled high with butter, each bearing on its half-congealed surface a dimly-burning wick in a little pool of self-thawed oil. These dim beads of yellow light provide all the illumination of the cave, and after a little one can just distinguish the solemn images squatting round the walls, betrayed by points and rims of light, reflected here and there from the projections and edges of golden draperies or features. The smell is abominable. The air is exhausted and charged with rancid vapors. Everything

FINE BRONZE STATUE AND MODEL OF THE ROYAL TECHNICAL HIGH SCHOOL, CHARLOTTENBURG.

GERMANY AT THE ST. LOUIS EXPOSITION.

one touches drips with grease. The fumes of burning butter have in the course of many generations filmed over the surfaces and clogged the carving of doors and walls alike. The floor underfoot is slippery as glass. Upon this receptive foundation the grime and reek of centuries have steadily descended, with results that may be imagined. Except that the images themselves apparently receive from time to time a perfunctory wipe with the greasy rag which is generally to be found in a conspicuous place beside a Tibetan altar, there is not in one of these numerous chapels the slightest sign of consideration, respect, or care.

One comes out again into the open air with relief, only to find, three or four yards on, the entrance to another of these catacomb-like chapels. They entirely surround the walls of this interior court, and to the eye of the stranger hardly differ one from another. Indeed, the monks themselves when questioned seem to find some difficulty in distinguishing the identity of the images in the successive chapels. In front of some of these recesses hangs a curtain of a curious kind, peculiar, so far as I know, to this temple. Horses' bits of steel and of a plain pattern, are linked together ring to ring by short lengths of twisted iron, the whole forming an original and effective screen. This is secured to the left-hand jamb by a long bolt and staple, and the whole is fastened by one of the gigantic locks which are adopted from China, and are perhaps the most ingenious product of the country.

The center of the court is taken up by an inner sanctuary formed on three sides by low shelves, covered with small brass Buddhas backed by larger images arranged between the pillars supporting the roof of the half-roof, and on the fourth side by a plain trellis of iron pierced by a similar plain gateway. From inside, therefore, none of the chapels or the statues ranged along the walls of the court are visible, and the darkness thereby caused under the portico is greatly increased by the half-drawn awnings, of which the ropes slant downward across the opening, and form perches for a special colony of orange and purple swallows, whose nests cling up to the overhanging eaves.

In this central court two statues sit; one—that to the left—is about lifesize, the other is of gigantic proportions. Both of them present the same peculiarity—one which cannot fail to arrest the eye at once. Each is seated upon a throne in European fashion, and this identifies them at once. Of all the Bodisats, heroes, or teachers which fill the calendars of Lamaism, only the image of the coming Buddha is thus represented. How this tradition arose the Lamas themselves are unable to explain, but it is of great antiquity, and it is to Europe that the eyes of Buddhism are turned for the appearance of the next reincarnation of the Great Master. As will be remembered, the Tsar of Russia was recently recognized as a reincarnate Bodisat, and it is not impossible that this legend paved the way considerably for his acceptance. Crowned with a huge circlet set with innumerable turquoises, Maitreya sits here with one hand raised in benediction, the other resting upon his knee. On his breast lies a tangled mass of jeweled chains and necklaces, and vast "roundles" of gold, set with concentric rings of turquoises, half hide his huge shoulders. We caught only a hurried glimpse as we passed on; for the order in which the sights of a Buddhist temple may be visited is invariable, and we took care not to offend the susceptibilities of the Lamas by deviating from the orthodox left-to-right course which forms part of their religious observances. The "way of the wine" is a custom which would need no explanation to a Buddhist.

Once under the eastern end of the Jo-kang, one finds the darkness deepen fast. There is no light but such as can find its way under the wide half-roofs and through the trellises, screens, and awnings which almost entirely close in the central court. In the gloom one passes by ancient chapel after chapel where the dim half-light barely reveals the existence of the dark recess guarded by its iron screen. The archaic walls share with the smooth-worn pillars the burden of the warped rafters overhead. The stone slabs under foot are worn into a channel, and the grime of a thousand years has utterly hidden the pictures—if there ever were any—on the walls. At last one turns to the right, passing close beneath the uplifted figure of the great Tsong-kapa, the Luther of Central Asia. It is a contemporary likeness, and one could wish that there were more light by which to see it than is afforded by the dim radiance of the butter-lamp before his knees. But his very posture is significant; for, instead of having his back to the wall behind him, Tsong-kapa faces south, and this is the first indication that we are at last drawing near to the Holy of Holies.

We have now reached the eastern end of the cathedral, and are passing behind the trellis work of the inner court; in the twilight it is difficult to distinguish the half-seen figures which people the recesses and line the sides of the path along which we grope our way. Ten paces more and the Jo itself is before us.

The first sight of what is beyond question the most famous idol in the world is uncannily impressive. In the darkness it is at first difficult to follow the lines of the shrine which holds the god. One only realizes a high-pillared sanctuary in which the gloom is almost absolute, and therein, thrown into strange relief against the obscurity, the soft gleam of the golden idol which sits enthroned in the center. Before him are rows and rows of great butter-lamps of solid gold, each shaped in curious resemblance to the pre-Reformation chalices of the English Church. Lighted by the tender radiance of these twenty or thirty beads of light, the great glowing mass of the Buddha softly looms out, ghostlike and shadowless, in the murky recess.

It is not the magnificence of the statue that is first perceived, and certainly it is not that which makes the deepest and most lasting impression. For this is no ordinary representation of the Master. The features are smooth and almost childish; beautiful they are not, but there is no need of beauty here. Here is no trace of that inscrutable smile which from Mukden to Ceylon is inseparable from our conceptions of the features of the Great Teacher. Here there is nothing of the saddened smile of the Melancholia who has known too much and has renounced it all as vanity. Here, instead, is the quiet happiness and the quick capacity for pleasure of the boy who had never yet known either pain, or disease, or death. It is Gautama as a pure and eager prince, without a thought for the morrow, or a care for to-day. No doubt the surroundings, which are effective almost to the verge of theatricality, account for much, but this beautiful statue is the sum and climax of Tibet, and as one gazes one knows it and respects the jealousy of its guardians. The legendary history of this idol is worth retelling. It is believed that the likeness was made from Gautama himself, in the happier days of his innocence and seclusion in Kapalivastu. It was made by Visvakarma—no man, but the constructive force of the universe—and is of gold, alloyed with the four other elemental metals, silver, copper, zinc, and iron, symbolical of this world, and it is adorned with diamonds, rubies, lapis-lazuli, emeralds, and the unidentified Indranila, which modern dictionaries prosaically explain as sapphire. This priceless image was given by the King of Magadha to the Chinese Emperor for his timely assistance when the Yavanas were over-running the plains of India. From Peking it was brought as her dowry by Princess Konjo in the seventh century. The crown was undoubtedly given by Tsong-kapa himself in the early part of the fifteenth century, and the innumerable golden ornaments which heap the Khil-kor before the image are the presents of pious Buddhists from the earliest days to the present time. Among them are twenty-two large butter-lamps, eight of a somewhat smaller size, twelve bowls, two "Precious Wheels of the Law," and a multitude of smaller articles, all of the same metal.

These are arranged on the three shelves of the Khil-kor, and the taller articles conceal the whole of the image from his shoulders downward. To this fact may perhaps be due the common, but mistaken, description of the Jo as a standing figure. Across and across his breast are innumerable necklaces of gold, set with turquoises, pearls, and coral. The throne on which he sits has overhead a canopy supported by two exquisitely designed dragons of silver-gilt, each about ten feet in height. Behind him is the panel of conventional wooden foliage, and the "Kyung," or Garuda Bird, overhead can just be seen in the darkness. Closer examination shows that almost every part of the canopy and seat is gilded, gold, or jeweled. The crown is perhaps the most interesting jewel. It is a deep coronet of gold, set round and round with turquoise, and heightened by five conventional leaves, each inclosing a golden image of Buddha, and incrusted with precious stones. In the center, below the middle leaf, is a flawless turquoise six inches long and three inches wide, the largest in the world. Behind the throne are dimly seen in the darkness huge figures standing back against the wall of the shrine all round. Rough-hewn, barbarous, and unadorned they are, but nothing else could have so well supplied the background for this treasure of treasures as the Egyptian solemnity of these dark Atlantides, standing shoulder to shoulder on altar stones, where no lamps are ever lighted and no flowers are ever strewn. Before the entrance, protecting the treasures of the shrine, is the usual curtain of horses' bits. This was unfastened at our request, and we were allowed to make a careful examination of the image. The gems are not, perhaps, up to the standard of a European market; so far as one could see, the emeralds were large, but flawed, and, as is of course inevitable, the pearls, though of considerable size, were lusterless; but it would be difficult to surpass the exquisite workmanship of everything connected with this amazing image, and a closer inspection did but increase the impression of opulence.

The altar below the Khil-kor is of silver, ornamented with conventional figures of birds in repoussé work, and one smiled to see in the most conspicuous place of all, thrown carelessly in a cleft between two of the supports, the usual greasy rag, with which the sacred image was daily rubbed.

Outside, the maroon-robed monks sat and droned their never-ending chant. We pass by them, and, after a glance at the Maitreya at nearer range, we were taken upstairs to the first floor, which runs only along the inner court, passing on our way the famous representation of Chagna Dorje. This, in one account of the Jo-kang, is said to be the statue round the neck of which a rope was once tied by order of the apostate, King Langdrama, to drag it from its place; thereupon the miscreant was, of course, promptly and miraculously destroyed. As a matter of fact it is an image cut in low relief upon the wall itself of the Jo-kang, gilded and colored, and honored always with rows of copper lamps. This is but another example of the inaccuracy which characterizes all the extant descriptions of the cathedral of Lhasa. It would be easy to multiply similar cases; in fact, hardly anything has been properly noted. On the first floor there are chapels maintained by the devotion of special races of the Buddhist faith. Among them the Nepalese chapel was pointed out.

Above, on the second floor, is an image which, after the Jo itself, is the most important treasure that the Jo-kang contains. In the southeastern corner of this story is the armory, where the walls and pillars alike are loaded with ancient and grotesque instruments of war. From this room a low, narrow passage leads down half a dozen stone steps into a small dungeon, where the statue of the guardian goddess, Palden Lhamo, is worshiped. This is a most amazing figure. The three-eyed goddess, crowned with skulls, grins affably with mother-of-pearl teeth from her altar; upon her head and breast are jewels which the Jo himself might condescend to wear. Eight large, square charm boxes of gold and gems, two pairs of gold-set turquoise earrings, each half a foot in length, and a diamond-studded fillet on the brow beneath the crown are perhaps the most conspicuous ornaments. Her breastplate of turquoise and corals is almost hidden by necklaces, and a huge irregular pearl, strongly resembling the "Dudley" jewel in shape, is at last distinguishable in the center leaf of her crown. Before her burn butter-lamps, and brown mice swarm fearlessly over walls and floor and altar, so tame that they did not resent being stroked on the lap of the goddess herself.

With this famous image of the guardian deity—who, as every Tibetan knows, from the Dalai Lama to the peasant in the field, was reincarnated during the last century as Queen Victoria—the list of treasures in the Jo-kang of a special interest to Europeans is perhaps concluded. But for the Buddhist scholar there is an unexplored wealth which it may be many years before any second visitor will have the privilege of inspecting, or the knowledge to appreciate. The great eleven-faced Shen-ne-zig, the "precious" image of Tsong-kapa, the innumerable figures of divine teachers, each symbolically representing the spiritual powers with which he was endowed, the great series of the disciples of Buddha, the statue of the Guru Rimpoche, the usual "chamber of horrors," and hundreds of other objects, each worthy of the great Pantheon of Lamaism—all these must for the moment remain unnoticed. But the longer one stays within these strange and sacred courts, the more amazing does the contrast appear between the priceless riches and historic sanctity of their contents and the squalid exterior of the most sacred structure in all the vast domain of Buddhism. Yet the face of the Buddha remains the dominant impression of the whole.—London Times.

[Concluded from SUPPLEMENT No. 1506, page 24135.]

THE RELATIONS OF TECHNICAL CHEMISTRY TO THE OTHER SCIENCES.—II.*

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TECHNICAL chemistry, in common with pure chemistry, is under lasting obligations to physics. It makes use of the physical properties of matter for purposes of identification and separation. It employs her instruments, such as the spectroscope, the polariscope, the microscope, the photometer, and a multitude of others in analytical operations. It utilizes the various manifestations of energy in accordance with the physical laws which govern them, adopting the methods of transformation, conveyance and application which the physicist has shown to be most efficient, convenient, and safe, though adapting them to the particular circumstances which obtain. It relies upon the physicist for the verification of its standards of mensuration; and, as previously stated, it employs physical together with chemical processes in its treatment of material in manufacture. A modern instance of this relation of technical chemistry to physics is found in the electrochemical industry. Starting with the remarkable experiments of Sir Humphry Davy in 1807, which resulted in the isolation of sodium and potassium, the commercial utilization awaited the discovery of an adequately cheap source of available electrical energy, which was realized on the invention of the dynamo in 1867. When its practicability was demonstrated, and especially after it had been shown that a head of water could be employed as the primary source of this energy, the electrochemical industry began, and achieved such proportions that in the year 1900 in the United States alone phosphorus, sodium, and other metals, not including aluminium, were isolated, and caustic soda, bleaching powder, and other bleaching agents, bromine and potassium bromide, potassium chlorate, litharge, graphite, calcium carbide, carborundum, and carbon disulphide, amounting in value to $2,045,535, were manufactured by electrochemical methods. Many other products have been obtained by this means in the laboratory and have been expected in the industry, but while the industry is a growing one it is not growing as rapidly in the variety of its products as some have been led to anticipate. Much depends upon the extent to which low-cost sources of energy are to be commanded, and on this point the following from J. W. Richards's presidential address to the American Electrochemical Society in 1903 is pertinent. He says: "Niagara Falls is the most accessible of our great water powers, and has therefore drawn into its fold the majority of our electrochemical industries. But another source of surplus power is distributed over a large part of our country, in a condition at present as undeveloped as was Niagara's power when Columbus touched our shores. I refer to the surplus power from blast-furnaces, obtainable by using gas engines. Every blast-furnace burns its gases to heat its blast and to raise steam for its power. The two-thirds of its gases used for the latter purpose generate just about the power needed for the blowing engines, pumps, hoists, etc., an amount equal on an average to 2,500 horse-

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power for a furnace making 500 tons of iron per day. If the gas thus used was in gas engines, there would be an average surplus power, over and above all requirements of the furnace itself, of 10,000 horse-power. The gas-engine plant needed to produce this power does not cost over $50 per horse-power investment. This compares favorably with the cost of developing water powers, which varies from $25 to $100 per horse-power. It is thus deducible, that there are scattered over the United States, in some of our most flourishing industrial centers, undeveloped powers which aggregate over 1,000,000 horse-power, which can be developed at no more cost than the average water power, can be generated just at the spots where they can be most favorably utilized, and without any more drain on our natural resources than the harnessing of a new water power, for not a pound of coal more would have to be burned than is used at present.

"Other possible sources of power are the waste surplus gases from by-product coking ovens, and the utilization of gas-producers, using cheap, almost waste, coal, in connection with gas engines. Power, therefore, is available in immense quantities in places and in countries not blessed with Niagaras in their midst, and the industrial development of such sources will be one of the most marked industrial movements of the next ten years."

While recognizing these many obligations to physics, as a *quid pro quo* technical chemistry supplies her devotees with all the "manufactured" materials which are the subject of their experiments and observations, or used in the construction of their instruments, or as sources of energy, such as coal-gas, acetylene, alcohol, and others, and the substances used for primary and secondary batteries. Many physical topics have originated with or been extended by the technical chemist.

The technical chemist looks to the forester, the farmer, and the miner for his raw materials, but he returns to the former alkaloids, wood alcohol, acetic acid, and acetates, acetone, formaldehyde, paints, rubber articles and a multitude of other products of manufacture; he returns to the farmer starch, sugar, artificial manures with which to reinvigorate his soil, fibers bleached or dyed, the suint from his sheep, the pepsin, pancreatin, and antitoxines from his swine and cattle, and through the agricultural chemist specific directions as to methods for the treatment of his soil and his crops. Since Liebig began the investigations which resulted in 1840 in his book on "Chemistry in its Application to Agriculture and Physiology," no one science has probably benefited more from the labors of the technical chemist than agricultural science, for well-equipped research laboratories with well-organized forces of chemists have been devoted by legislation to this purpose to a greater extent than to any other, and the publications from Dr. Wiley's laboratory alone indicate how valuable this has proven to be. As one among many examples we may cite the sugar industry, which owes its existence to-day in this country, whether the source be sugar cane, or beet, or starch from maize or potato, to the technical chemist.

The technical chemist returns to the miner the metals, isolated from his ores, in the form of tools and machinery, or coins, or converted into compound substances available as medicines, as disinfectants, as detergents, and for a variety of purposes, and he supplies him with his explosives through which his labor is rendered much less arduous and his life more secure.

The technical chemist looks to the civil engineer to provide the means for the transportation of his raw material and his manufactured products and to the mechanical engineer for his constructions and his machinery, but he supplies them with all the manufactured materials used in their work and guarantees by analysis the quality and character of the natural as well as the artificial materials required. So rapidly has this method of chemical supervision come into vogue in the last half century that the engineer, whether he is to build a hotel, a ship, a locomotive, a gun, or a bridge, to lay a concrete foundation or to surface a road, now introduces into his specifications the chemical requirements which the material must satisfy in order to be accepted for use, and he depends upon explosives to enable him to drive his tunnels, sink his shafts and remove obstructions from his course. It has excited no particular remark that a chemical laboratory has been established as a part of the preparations essential to the building of a tunnel under the Hudson River.

To the metallurgist technical chemistry has been invaluable, as it has improved the quality, decreased the cost, and increased the speed of production of his materials. The story is an interesting one as we follow it either among the precious or the common metals. As set forth by Bridge in the "Inside History of the Carnegie Steel Company," where we trace the growth from the Kloman forge of 1853, worth complete $4,500, to the Carnegie Company of 1899, valued at about $500,000,000, the story is a fascinating one in many ways, but in none more than in such rivalries as that between the blast furnaces started by the Lucy and Isabella furnaces and entered into by the Edgar Thomson, the Carrie, and the Youngstown furnaces, by which the output of pig iron was increased from 50 tons in each twenty-four hours to 901 tons in the same period, while the coke consumption per ton of iron was reduced by 50 per cent. No one with sporting blood in his veins but feels a thrill as he follows these records at the blast furnace, the Bessemer converter, the open hearth, and the rolling mill, and especially as he realizes the tremendous issues involved and the enormous amounts of money at stake, and everywhere he finds it is only by the close and constant supervision of the chemist that these results could have been attained, while the quality of the product was assured. The authority of the chemist in these enterprises has been extending over a continually widening territory and becoming more positively recognized, so that, taking again the blast furnace as an example, where at first he was occasionally employed to analyze the ore used or the pig iron produced, he now analyzes all of the fuel, flux, and ore that goes in at the throat and the gases, slag, and metal that are produced in the furnace. One has but to casually examine a modern technical work such as Harbord's "Metallurgy of Steel" to be convinced of the absolute dependence of the modern steel maker upon the technical chemist. Mr. Carnegie admits that he owes his success in steel making to having been among the first to employ chemists throughout his establishments, and we find that the other industrial combinations, such as the Standard Oil Company, Amalgamated Copper, and the like, which consider no detail of business too small to be ignored, employ chemists at all points auditing their operations, accounting for their materials at all stages, stopping wastes, diminishing costs, improving the quality, and increasing the speed of manufacture.

Technical chemistry then invades the domains of economics, of politics, and of diplomacy. A striking example of its effects in economics and politics is found in the settlement of the silver question. Gold is a most widely diffused metal. It has, for instance, been shown by assayers at the United States mint at Philadelphia that if the gold in the clay of the bricks of which the buildings of the Quaker City are built could be brought to the surface the fronts would all be gilded. In the past our processes for the isolation of this metal have been so costly that only the richer ores would bear treatment. Large bodies of low-grade ores which had been discovered and mountains of tailings carrying values were looked upon as worthless, while enormous quantities of copper, lead, and other metals containing gold were sent into the market to be devoted to common uses because the cost of separation was greater than the value of the separated products. Eight years ago, when the "silver question" was made the national issue, while the orators were declaiming from the stump, the chemists were quietly working at the problem in their laboratories and factories. Manhes's process for bessemerizing copper ores was combined with the electrolytic refining of the product so that even traces of gold were economically recovered, while the cyanide processes, such as the MacArthur-Forrest, the Siemens-Halske, the Pelatan-Clerici, and others, for the extraction and recovery of gold from low-grade ores and tailings, were successfully worked out and put into practical operation to such effect that by the cyanide processes alone gold to the value of $7,917,129 was recovered in the United States in 1902, which is more than was ever won throughout the whole world by every method in any one year up to 1661 and probably up to 1701. The data for other processes is not at hand for 1902, but the returns for 1900 show that gold to the value of $88,985,218 was recovered in the treatment of lead and copper ores in the United States, of which $56,566,971 worth was recovered in refining. It has but recently been publicly proclaimed in this city of St. Louis that the "silver question" is settled, but it was settled largely through the efforts of the technical chemist and metallurgist.

Technical chemistry renders important services to medicine in furnishing it with an enormous variety of remedial agents, anæsthetics, and other supplies. It is an important factor in the public health service, supplying disinfectants and deodorizers, inspecting food supplies, supervising water supplies, devising methods for the purification of sewage, the treatment of wastes, and the prevention of the pollution of the atmosphere. We have but to mention the names of Pasteur and Pettenkofer, of Letheby and Wanklyn and of Drown, Chandler and Mrs. Richards to emphasize the importance of the chemical factor.

Chemistry is an equally important factor in public safety. A glance at Von Schwartz's "Fire and Explosion Risks" will show how varied and extensive but a single one of these fields of activity is. Every one of you as you came here by boat or rail owed a large measure of your safe conveyance to the technical chemist. The regular utilization of these valuable services in this interest is of quite recent date. It was in 1875 that some of the officials of the Pennsylvania Railroad Company, finding that the oil used in their signal lamps and headlights was unreliable and that all empirical methods of examination failed, determined to employ a chemist. Dr. Charles B. Dudley was called, a laboratory was opened at Altoona, and in the face of the skepticism of the "practical" man the work began and was carried to so successful an issue that a multitude of problems relating to railroad administration have been referred to the chemist, his force of skilled assistants has been steadily increased, and the position of the chemist in the organization is second to none in importance. Other railroad companies, recognizing the gain in economy and efficiency have also instituted chemical laboratories, until in thirty years it has become common practice. While the Pennsylvania Railroad Company was wrestling with the question of testing oil, the United States Lighthouse Board was having trouble from the same cause, the lamps in the lighthouses and beacons along our coast, harbors, and navigable waters having become quite unreliable from the character of the oil furnished, and it, too, sought the aid of the chemist, with such result that it has ever since relied upon chemical science to define and pronounce upon the quality of its supplies.

It has been said that the state of civilization of any country may be determined by the amount of soap which it consumes. Lord Beaconsfield considered that the condition of the chemical trades constituted the best industrial barometer. In his pamphlet on "The American Invasion, or England's Commercial Peril," when discussing "the best index of a nation's prosperity," B. H. Thwaite says: "Had he (Beaconsfield) selected the iron and steel trades, he would have made a far better choice." I have given these citations from the many at command as illustrating the tribute paid by the thoughtful to technical chemistry. Technical chemistry promotes civilization, profoundly modifies national policies, and influences diplomatic proceedings. The most frequent cause of friction between nations to-day is found in the endeavor of each of the world powers to control territory for the exploitation of their products or as sources of their raw materials.

Technical chemistry, as practised in the past, from the dawn of manufacture, is a most important subject for consideration by the anthropologist, which has unfortunately been too much neglected. Its study will bring rich yields to the anthropologist who comes to it with the proper preparation, for he will find in the arts embraced in technical chemistry the best gage of the extent of civilization of a people. Historians agree that no one material thing has more profoundly influenced civilization than gunpowder. Over fifty years ago, under circumstances somewhat similar to those which obtain here, a body of scholars under the leadership of Dr. Whewell, master of Trinity College, reviewed the results of the famous exhibition which had just been held in London. I desire to call the attention of the anthropologists to the address there given by Sir Lyon Playfair on the "Chemical Principles Involved in the Manufactures of the Exhibition."

In the autumn of 1874 I was so fortunate as to be the guest, at his residence in the Smithsonian Institution, of Joseph Henry, its first secretary and executive officer from 1846, and I had the precious privilege of hearing from his lips a most detailed account of the development of the institution from the time when he was assigned the duty of devising and carrying out the plans by which Smithson's wishes should be realized and the provisions of the legislative act creating the institution complied with, and particularly of the various obstacles which he had encountered and surmounted in his endeavor to use the fund for "the increase and diffusion of knowledge among men" in the spirit in which Smithson, as Henry understood it, intended it should be used. Naturally my interest in the famous institution was greatly quickened and I have watched somewhat more keenly the subsequent career of this institution and of the organizations such as the Library of Congress, the United States Department of Agriculture, the National Museum, and others created or fostered by it. From the outset, however, I have remarked upon the absence from the museum of any collection relating to technical chemistry, which is so profoundly connected with the history and development of civilization, and which has undergone itself, in its development, so many changes that its tools and appliances and methods disappear completely from view unless preserved in some such historical collections as those made by the museums. I have endeavored by suggestion to have this oversight remedied, but have been met by the reply that the present building is overcrowded and its resources overtaxed by the mass of material collected in branches at present cultivated. As now the museum is starting on a new career of usefulness and a new structure of greatly increased capacity is being built, this seems an opportune time to publicly seek this recognition for industrial chemistry, at least in the anthropological collections, and particularly when, as now, to a greater degree than at any other period, such rapid changes are going on in long established and important industries, such as the sulphuric acid and alkali industries, that the processes of the last century may become among the lost arts of the next century.

Within the present year the remains of Smithson have been removed from the soil of Italy, in which they so long rested, and been reverently and fittingly interred within the confines of the noble and beneficent institution that he founded. The revival of personal interest in Smithson which this removal has aroused has led to the suggestion that a monument be erected to his memory. The Smithsonian Institution is itself an enduring monument, but if another be created could it not, considering that Smithson was a chemist, fittingly take the form of a chemical collection in the museum which so long benefited by his bequest?

Starting from Huyghens's theorem that any normal to the direction of the oscillation of a pendulum is cut by a semicircle, described above the amplitude, at a distance which is proportional to the velocity of the oscillating point at the foot of the normal, F. von Hefner-Alteneck shows in an elementary way that any accelerating force will quicken the movement and diminish the period when it is applied in the first part of the oscillation, and will retard the movement when applied in the second part of the oscillation. He demonstrates that this holds for the air resistance, with the aid of a pendulum whose bob is replaced by a flat strip at right angles to the direction of the oscillation; a short tube is attached to the strip and closed at the far end by a piece of thin paper attached to a horizontally-stretched thread. Reference is made to escapements in clockworks. When suggesting in 1888 to regulate the pendulum motion with the aid of a small weight, to be raised and dropped again by the fork, the author did not consider the importance of the point of application as explained above.

UTILITY OF AUTOMOBILES FOR WAR OPERATIONS.

The success which the automobiles had during the recent French military maneuvers is very encouraging, and it is recognized that they are a valuable auxiliary to the army. Every year sees a greater number of cars entered and the leading military authorities approve them highly. This year an unusually large number of chauffeurs took part in the maneuvers. On his return, one of them gave his impression of the event in a recent interview. "The twenty-eight days were passed admirably, on my part, as I was attached in quality as chauffeur to Gen. Pendezec, Chief of the *Etat Major*, who is one of the first to appreciate the services which the cars can render to the army. With him I did not remain idle, seeing that I took in both the eastern and western maneuvers. Like all the chauffeurs who piloted one of the generals, my principal duties were to conduct the chief to the places where his presence was necessary, and of course as rapidly as possible. Where under the old system the generals started off on horseback to reach the ground at least an hour before the maneuvers took place, they now start only a quarter of an hour before the required time and upon reaching the field they find their horses, which have been brought there in advance. In my own case this kept me rather busy on account of the high grade occupied by Gen. Pendezec. As Chief of the *Etat Major* he was obliged to conduct both the East and the West maneuvers. This complication in the service was in reality a pleasure for me, as it took me over considerable ground." As to the use of the automobile not only for the above service, but also in the strategic part of the maneuvers, one of the leading officers (who did not wish to give his name) expressed the opinion that the cars would, no doubt, be very useful in this connection, and in fact, the question is now being considered. Some experiments have already been made, he says. "During the last maneuvers, Capt. Genty, mounted on a 24-horse-power car belonging to the army automobile corps, was charged with making a strategic experiment which gave excellent results. It was carried out as follows: Capt. Genty was attached to one of the cavalry divisions. In course of the maneuvers he served to unite the main body of the cavalry with the scouts, which were scattered in different directions, and he thus brought the information which the scouts obtained to the main body of the cavalry, and this very quickly. There is no doubt that in next year's maneuvers the question will be further taken up and some interesting experiments may be looked for. What these are to be I am not at liberty to say at present."

AUTOS ABOUT TO START ON A RECONNOITERING EXPEDITION.

The example first set by the French several years ago of the application of automobiles to war purposes has been followed by several other European nations, especially Germany, and also this year by the United States. Our illustrations depict some of the cars that were used this fall in the German maneuvers, where they were found of very great use for the speedy transportation of officers to different parts of the field. Even Emperor William himself made use of a fine large touring car as a conveyance to and from the field of operations.

Two of the best makes of American automobiles—the Winton gasoline and the White steam cars—were given severe tests by Generals McArthur and Corbin in the maneuvers this year at Paso Robles, Cal., in the West, and at Manassas, Va., in the East. At the former place a Winton touring car was used almost incessantly, while at the latter three White steam tonneaus did fine work. A specially-built Winton machine, with side seats like a bus, capable of accommodating six, also was found very serviceable by the United States Signal Corps, who used it as a movable telegraph station.

The Winton car used in the Western maneuvers covered the 283 miles from San Francisco to Camp Atascadero in a little over two days. Once on the field, it was used by General McArthur all over the field, which had no roads whatever, but consisted of wheat stubble three feet high, river bottoms, ditches, and mountain sides, having grades of 30 per cent. During the twenty-one days the car saw service in camp, it covered from 40 to 112 miles a day, yet not a minute's time was lost from repairs to the car or its mechanism. General McArthur stated that it would have taken him four days' tiresome riding on horseback to reconnoiter the ground covered in the machine in six hours.

Major-General H. C. Corbin, who used a White steam car at Manassas, was equally well pleased. He left his headquarters at 6 A. M. (three hours after the members of his staff), yet notwithstanding the bad character of the roads, he reached the rendezvous before them. As a result of these trials, the probabilities are that automobiles will soon come into more general use in the American, as well as in foreign, armies.

DEBRIS-RESTRAINING BARRIERS OF THE YUBA RIVER.*

By Capt. Wm. W. Harts, U. S. Corps of Engineers.

In the years following the discovery of gold in California, the processes of mining for this precious metal caused the removal of vast quantities of detritus from the western slopes of the Sierra Mountains into the streams and rivers of the valleys below. Gold was found in the beginning in gravel beds, where it had probably been deposited by rivers flowing in prehistoric times. These gravel beds exist in great numbers in a comparatively small area along the western slopes of the Sierra Mountains near the headwaters of streams draining into the Sacramento and San Joaquin valleys.

In securing gold from these mountains the sorting action of water was necessary, and in order to facilitate mining operations, ditches of great length and size were built, frequently at great expense, to carry water to the localities where gold had been discovered. Streams of water under great pressures were directed at these gravel banks through nozzles sometimes as large as nine inches in diameter, to break down the gravel banks and wash the detritus through sluiceways where the gold could be caught. Streams carrying as much as 3,500 miner's inches were not uncommon. It is thus easily seen that such powerful agencies would rapidly wash down whole hillsides, which would naturally be carried into the canyons and small streams in the vicinity of the mines, to be washed farther and farther down stream with each succeeding rainy season.

These mining operations were carried on for a number of years without interruption until the valley country below became more thickly populated, when the injuries caused to the rivers and the neighboring farm lands became important enough to cause those damaged to seek legal redress. By 1883 the action of the courts in California had completely stopped this sort of hydraulic mining, putting an end to an extensive industry that had originally been the principal cause in building up what was then an unknown region. Great bitterness arose between the miners on the one hand and the farmers on the other that apparently could not be settled by the State of California. Ten years afterward Congress enacted a law by which the California Debris Commission came into existence, which was to consist of three officers of the Corps of Engineers, United States Army, appointed by the President, who were to permit hydraulic mining under such conditions as not to allow injury to the navigable waters of the United States, if methods could be devised. The Commission was also charged with the duty of perfecting plans for such treatment of the rivers of the Sacramento and San Joaquin valleys that their former condition as to navigability would be restored as far as practicable and necessary. Incidentally any project adopted by the Commission for the protection of navigable streams from mining debris would also prevent the injurious filling up of the lower rivers that had already caused widespread damage to bordering farms by the floods due to the raising of the beds of the rivers. For this reason the State of California, realizing the benefit to the people in the great central valleys of the State, agreed to pay one-half the cost of any project that should be approved by the United

GERMAN WAR AUTOMOBILES READY TO START WITH OFFICERS FOR THE MANEUVERS.

* Specially prepared for the Scientific American Supplement.

States for the prevention of the escape of mining detritus into the lower rivers.

In 1900 a plan was recommended to Congress by the California Debris Commission for the treatment of the Yuba River. This river was selected because it had suffered more than any other river in California from the accumulation of mining debris. In 1849 the Yuba was a narrow mountain stream with steep, high banks in its upper portions, but winding through the lowlands to its mouth in the Feather River near Marysville. At the present time this stream contains, it has been estimated, in the neighborhood of 71,000,000 cubic yards of mining detritus. The lower river, formerly a narrow, winding stream, is now in the neighborhood of three miles in width, and the depth of debris varies from twenty-four feet at Daguerre Point up to about 125 feet at Smartsville. Through this debris the river winds in a narrow thread at low water, but at high stages the entire bed is covered many feet deep with a rushing flow of water. The city of Marysville, to protect itself, erected levees around the town and along the river to Daguerre Point. These levees have been added to as the river filled until now the river bed is higher than the level of the land outside the levees in some places as much as 13 feet. A break in these levees at high water would mean a disaster for Marysville. This mass of detritus in the river bed consists in the upper portions of heavy bowlders lying on a slope of about 20 to 25 feet to the mile, and in the lower portions of fine sand and silt, the grade being considerably less than 10 feet to the mile. All this material is easily moved under the action of water, consisting as it does of round particles, so that the constant tendency of each season is to move more and more material from the upper regions to the already congested lower reaches, and thence into the Feather and Sacramento rivers.

The plan proposed by the Commission provides first for holding in place the enormous quantity of material already in the river bed, and also for preventing the further addition to this amount by holding back such as may in the future be carried down. The plans proposed by the Commission may be divided into three portions:

First, barriers across the river just below Smartsville, to prevent the addition of coarse detritus from the upper branches.

Second, embankments and settling basins in the vicinity of Daguerre Point, six miles farther down stream, for the impounding of fine material.

Third, confining the river to a selected channel by means of training walls in the reaches between Daguerre Point and the Feather River.

The estimated cost is $800,000.

The barriers comprise a system of dams, or weirs, extending entirely across the river bed, Barrier No. 1, the lowest, being about four miles below Smartsville. Barrier No. 2, about one-half mile above No. 1, will impound material until it backs up to the bridge crossing the river in the vicinity of Smartsville. When these two barriers have been built, it is contemplated building others farther up, should they be found necessary. From the nature of the river bed and the shortness of the working season, it will readily be seen that the construction of any kind of dams in the Yuba River is a matter of great difficulty. The low water flow of the Yuba River varies from 375 to 500 cubic feet per second, whereas the high water flow, due to the warm rains of spring and the melting snow of the mountains, sometimes amounts to as much as 100,000 cubic feet per second. The entire bed of the Yuba River for many feet deep is composed of material that resembles quicksand and affords a foundation of treacherous character. Several attempts have been made to dam the Yuba River in past years, both by the State of California and the United States, but no dam has ever up to the present time withstood the first high water season. It was plain from experiments made by the United States that no ordinary structure can ever be expected to withstand the rush of water of the early spring. The experience of the British in India comes the nearest to a precedent for a design for restraining dams in this river, but even such dams were not available for this site on account of the different duty to be performed.

Barrier No. 1 is about 1,200 feet long and will have a by-pass at one end, which, when completed, will take a large proportion of the flood water, relieving the dam from undue hydraulic action. This dam is to be, speaking generally, a toe for Barrier No. 2, which, on account of its much greater height, would be the actual restraining barrier for this location. Barrier No. 1 would therefore protect Barrier No. 2 from scour and backlash and incidentally store a large quantity of material. The present dam adopted by the Commission will be seen to be, therefore, largely an experimental one, and whether this type will be followed in the future will depend upon its action during the test of the next spring floods.

The plan for Barrier No. 1 may be briefly described as consisting of four rows of piles extending completely across the river, bulkheaded with timber both above and below to as great a depth as could be reached with ordinary means. An embankment of heavy, loose rock extends across the river between the first two rows of piles, and on this embankment are laid concrete blocks molded in place, 18 inches thick, and weighing from 10 to 12 tons. A roller way connects this with a wide apron 24 feet in width at the level of the river bed, its whole surface consisting, also, of concrete blocks about 10 feet square and 18 inches thick. The crest of the dam is 6 feet above the level of the apron. The upstream slope is made of large rock laid in Portland cement mortar, so that the dam practically consists of masonry anchored in place by piles driven from 30 to 35 feet in the river bed. The rows of blocks up and down stream are all connected with wire cables built in the concrete, thus affording a number of hinges about which the blocks are able to revolve, the upstream ends of these cables being anchored in the masonry of the face of the upstream slope. These blocks are unsupported except by the river bed, being separated from the piles by narrow concrete strips with tarred paper joints, so that in case of any considerable scour the blocks will follow down and prevent any excessive undercutting. The piles are for anchorage. In addi-

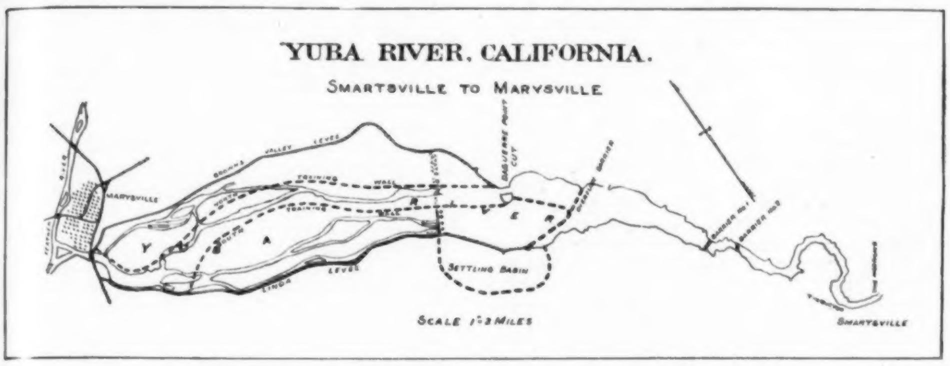
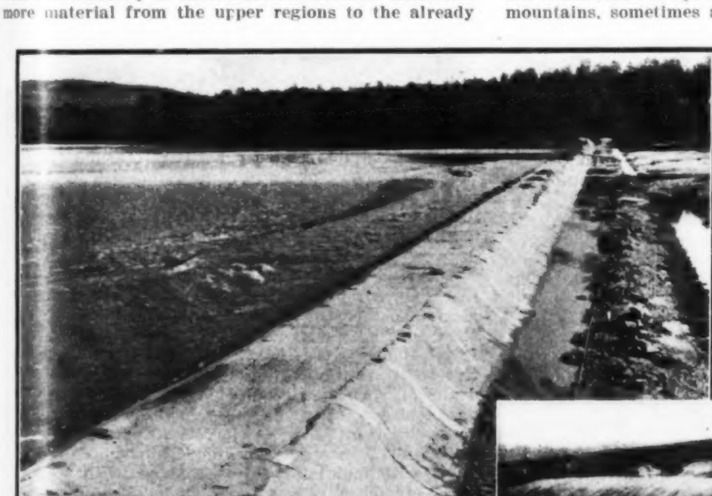
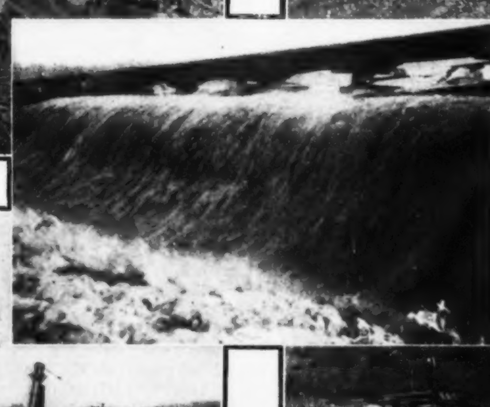


DIAGRAM SHOWING IMPROVEMENTS IN THE YUBA RIVER DISTRICT.

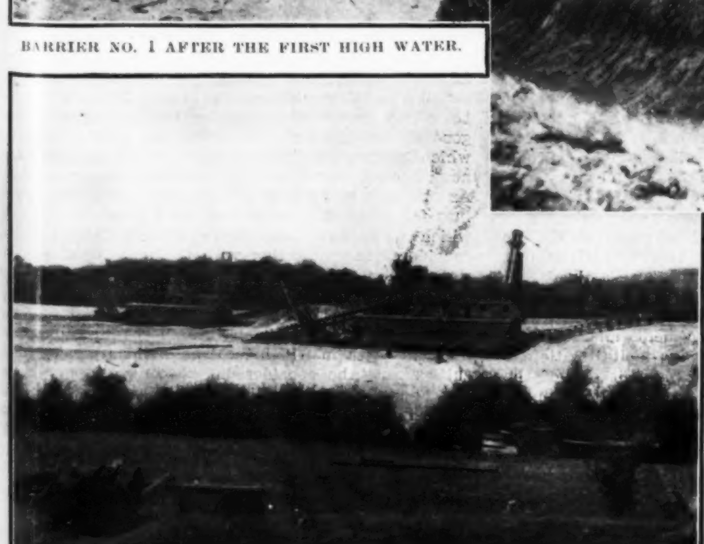


BARRIER NO. 1 AFTER THE FIRST HIGH WATER.

DAGUERRE POINT CUT.



HIGH WATER PASSING OVER BARRIER NO. 1.



GOLD DREDGES BUILDING EMBANKMENT NEAR DAGUERRE POINT.

PLACING CONCRETE IN BARRIER NO. 1.

THE IMPROVEMENTS ON THE YUBA RIVER.

tion, the lowest row of piling is driven to a depth of 40 feet and the piles are placed 3 feet centers, forming a wall of piling at the toe of the dam which it is hoped will be strong enough to prevent any scour from backlash. The lower step of this dam has just been completed and it remains to be seen what effect the coming winter will have upon it. If it should remain intact, it is expected to add to it by another similar step placed above and upstream of its present crest, forming a second step 7 feet higher. A third similar step will complete this dam to a height of about 20 feet. It is necessary to build this dam in steps, first, because the season for work in the river extends only from about the first of July to the first of November, and second, as it is not desired to raise the elevation of the barrier more than will probably be filled by the detritus brought down in a single high water stage. Already this new work has had an unusually severe test without showing any special weakness. A sudden freshet before the work was finished passed over the dam to a depth of nearly 4 feet. Racing currents along the face and toe damaged some of the uncompleted portions, but the finished work was left without showing the slightest weakness. This test is very encouraging.

The settling basin in the vicinity of Daguerre Point will form a supplement to the barriers. All the water of Yuba River, except during extreme high stages, will be conducted into a settling basin consisting of two square miles area, lying south of the Yuba River. This basin is surrounded by high ground on the east and south and will be closed along its lower western portions by an embankment. Water will be turned into these settling basins by a heavy embankment of gravel extending across the river, connecting Daguerre Point on the north with the southern bank, which embankment will be constructed on a V-shaped plan with the point extending upstream. This embankment will be 200 feet wide on the base and about 30 feet high, sufficient height being given it to prevent its ever being overtopped by extreme high water.

The whole river flow below the level of a diverting weir extending from the point of the V-shaped embankment to the shore will be admitted into the settling basin by adjustable gates and likewise the flow out from the basin will also be regulated. This basin, it is estimated, will hold 14,000,000 cubic yards of fine material. The flow at stages above the level of this diverting weir will pass through Daguerre Point cut and thence direct into the Feather River, the velocity being usually sufficient to prevent any injurious settling in the navigable reaches. At extreme high water the settling basin will be closed.

Through Daguerre Point is being made a cut 600 feet wide and 25 feet deep, to take the whole high water flow of the Yuba River when the settling basin is not in operation. At such stages it is impossible to do much with the enormous volume of water passing down stream except check its velocity in the lower reaches and encourage deposit of any sediment carried. Already this cut at Daguerre Point, which involves the excavation of about 750,000 cubic yards, has been over one-third completed.

Arrangements have been made with companies engaged in dredging for gold in the bed of the river to construct the embankment referred to above, incidental to their dredging operations. This work is also at present under way.

We thus see that practically all the coarser material brought into the Yuba River will be held by the upper barriers, and all the finer material, during the most of the year, will be carried into settling basins where it will be impounded, so that there only remains to complete the project some plan for holding the lower river in its position to prevent its being washed into the Feather River by scour. This it is expected to effect by a series of training walls placed at such distance apart that all the ordinary flow of the river will be confined within the banks laid out.

These training walls are to be built of brush work, so that at extreme high water the basins on both sides as far as the levees may be flooded, but the water will be so checked that the sediment will be deposited, causing the banks to be built up. All side sloughs will be closed so that the tendency for the river will be to flow in the course laid out. Work at present on this part of the river consists in closing the side sloughs and in securing titles to the land on which it is expected to place regulating works. Ultimately these side areas outside the training walls and within the river levees may be used as settling basins when the basin now being provided has been filled.

It may be thus seen that there will be ample room for many years for the storage of mining detritus. This project is a novel one and has no counterpart in engineering experience as far as known. Its novel engineering features, connected with its extensive character, give it an exceptional interest.

CONTROLLING THE BOLL WEEVIL IN COTTON SEED AND AT GINNERIES.

THE United States Department of Agriculture has just issued a Farmers' Bulletin entitled "Controlling the Boll Weevil in Cotton Seed and at Ginneries."

The bulletin was prepared by Mr. W. D. Hunter, Special Agent in Charge of Cotton Boll Weevil Investigations of the Bureau of Entomology, and calls attention to the fact that the extent to which cotton seed and ginneries are factors in the dissemination of the boll weevil has not been realized generally. The Bureau of Entomology has paid particular attention to this matter during the present season and has demonstrated that ginneries are the most important single factors in disseminating the pest. At least in regions where the cotton fields are somewhat isolated, spreading of the insect by flight, aided by the wind, seems to be of little importance compared with this artificial agency. The co-operation of the department with the Louisiana crop pest commission, which is engaged in an attempt to prevent the further entrance of the weevil into that State, has given many opportunities for determining the exact means whereby weevils reach new regions. This work has led to the conclusion that if it were possible to control the pest at gins, it might be possible to greatly retard its present rate of spreading, but without any such means of control there is great doubt about the feasibility of an attempt to check its spread, unless, indeed, measures are taken to prohibit in uninfested localities the ginning of cotton from infested regions.

As soon as the facility with which the boll weevil is disseminated in cotton seed was understood, the Bureau of Entomology devoted considerable attention to the possibility of destroying the pest by fumigation. Only two gases (carbon bisulphid and hydrocyanic acid) seem to be at all suitable for the purpose, and directions as to the manner of using them are given in the bulletin. Suggestions are also given as to the means of controlling the weevil at ginneries, and the manner in which weevils may escape from oil mills to cotton mills in the vicinity is described.

The bulletin concludes with the following recommendations:

It should be understood that complete success in keeping the boll weevil out of cotton seed depends upon a combination of the following recommendations for the seed-cotton storage house, in addition to a combination of the recommendations for the ginhouse proper. No one alone could be depended upon. On account of the great seriousness of the boll-weevil problem, the importance of these recommendations deserves the careful attention of every ginner, and farmers should realize that it is decidedly to their advantage to have their cotton ginned where the greatest care is taken with the seed.

I. Where possible a separate seed-cotton storage house should be provided. In any case, the seed should be stored in a building distinct from the seed-cotton storage house.

II. In the seed-cotton storage house should be installed special cleaners or droppers, which, in addition to removing many weevils, would facilitate ginning and improve the sample.

III. In the ginhouse proper the principal recommendations are that cleaner feeders and cotton cleaners be used more extensively, that the trash therefrom be treated in such a way as to cause the destruction of the weevils, and that a device be perfected for removing and destroying the weevils in the seed and motes.

IV. Wherever the system of handling and ginning cotton is not found to be effective in removing the weevils, and this is the case in practically all the smaller and many of the larger ginneries in Texas and Louisiana, the seed, at least for planting purposes, should always be sacked and fumigated by the ginner in the manner described. In regions where the cotton fields are isolated by this means the introduction of the weevils could be delayed considerably.

V. In addition to the care necessary with the seed for planting purposes, the farmer should also take great pains to prevent the introduction of the weevil in seed or hulls for feeding purposes, as well as in refuse from the ginneries, which is sometimes used as a fertilizer. There is no appreciable danger in cake or meal.

VI. At present it does not seem possible to control the boll weevil effectively at the oil mills. The importance the mills at present have in disseminating the weevil, however, could be very materially reduced by the proper care at gins.

The bulletin is for free distribution and will be sent to any address on application to senators, representatives, and delegates in Congress, or to the Secretary of Agriculture.

DRAINAGE INVESTIGATIONS.

BULLETIN No. 147 of the Office of Experiment Stations, issued by the U. S. Department of Agriculture, is a report of drainage investigations carried on by that office during 1903, under the direction of Elwood Mead, chief of Irrigation and Drainage Investigations. This is the most important work of the kind attempted by the Department, thus forming a new feature of investigations along agricultural lines; yet, judging from this report, it covers a broad and important field. The bulletin has a special practical value from the fact that local field conditions have been examined and dealt with and the methods of treatment which are applicable to each case are briefly discussed. The wide range, specific differences of treatment, and financial and sanitary importance of drainage in its relation to the improvement of farm lands, make it one of the most unique subjects which engage the attention of agriculturists in many localities. As the report says, so many phases of the drainage problem are involved that any investigation resolves itself into an examination of individual cases in each locality and the particular difficulties there encountered. The application of drainage to irrigated lands is shown to occupy an important place in the restoration of fields which have passed beyond the limits of profitable production by reason of over-irrigation; or perhaps, putting it in another way, by reason of lack of natural drainage facilities to care for the surplus water used in irrigation.

A description of examinations made at Fresno, Cal., during 1903, shows the method of arriving at the volume of water that should be removed from the soil. A plan for the drainage of about 25 square miles of territory is suggested to meet these water conditions and also the peculiar nature of the soil and character of the crops grown in that locality. The report shows that more than ordinary attention has been devoted to this field. The gravity of the situation and the importance of the results which would follow if drainage were provided for this noted vineyard country are sufficient reasons for the careful work thus far done.

A discussion of the drainage of irrigated lands in portions of Yakima Valley, Wash., and Greybull Valley, Wyo., forms an interesting part of the report bringing out features of the drainage problem which have hitherto received but little attention. Farmers of irrigated land are urged to give special attention to this subject, as may be noted in the following paragraph:

"With reference to the details of this matter no better advice can be offered than this: Bearing the general principles well in mind, each farmer should study his own situation—the position of the hardpan, the differences of soil, and the contour of the land, all of which have an influence upon the drainage of each individual tract. The indications of seepage water must be watched for closely and headed off as early as possible, for the history of this matter shows that the evil will not of itself leave the land, but will increase rather than diminish. Better practice in the use of water will doubtless soon prevail, but the necessity for drainage of certain irrigated lands will always exist, so that every rancher should be familiar with methods of drainage as well as irrigation."

The drainage of lands under rainfall is not a new subject, but is always an important one in the development of farms, either old or new. New men are constantly entering the agricultural field. Men more or less experienced in agriculture in one locality go to another and confront new difficulties in draining their lands, so that new phases of the subject appear at points where least expected and demand the prompt attention of the landowners. The treatment of some large drainage projects in Iowa is discussed in the light of existing conditions. Preliminary work in the development of these large fields is not always done with sufficient thoroughness. The following suggestions to drainage engineers indicate their responsibility in the matter:

"Preliminary surveys should be complete and full data should be gathered and placed on the maps. Every owner of land within a proposed district is concerned and his interest should be looked after minutely in the development of a drainage plan. A series of bench marks should be established in each district, so that when repairs on ditches are required, the original grade line may be reproduced and the ditches cleaned out to the depth originally dug. Amended maps and profiles of the work as finally completed should be filed for future reference. The value of these will be appreciated when it is remembered that practically every owner of land who pays an assessment toward the cost of the work has acquired certain drainage rights which will pass to consecutive owners. The improvements are permanent and are of public as well as private value."

The report describes the examination of particular cases which represent a class, for the purpose of suggesting methods of handling problems in other localities where similar conditions and difficulties exist. It is valuable along these lines and especially suggestive to those who have the direction of preliminary drainage work of a comprehensive character. A few pertinent conclusions are here noted as indicating the general scope of the work accomplished:

"While the necessity for the drainage of irrigated lands will doubtless be less obvious when water is more economically used and supply canals are improved in such a way as to diminish leakage, a considerable loss of water from both causes will always be unavoidable, so that drainage will always be an essential part of the improvement of irrigated land in some localities.

"The complete drainage of farm lands in humid belts can be effected only by the enlargement and general improvement of the minor arterial streams which receive the drainage and by the excavation of new ditches where natural streams are insufficient. As the low lands near the streams are transformed into farms, they must be protected from the overflow which periodically endangers them. This must be considered in connection with the more complete improvement of higher lands, the drainage of which contributes to the supply of main streams. So many phases of the drainage problem are involved that the investigation resolves itself into an examination of individual cases in which local as well as general difficulties must be considered.

"The ultimate removal of the surplus soil water from the fields is the end sought. At the same time, the proper conservation and distribution of the water should be considered more fully in the improvement of farm lands than it has been in the past. The rate of removal of water from soils should be as slow as is consistent with efficient drainage."

The drainage legislation enacted in 1903 shows the importance with which the subject is regarded in States having inadequate drainage laws. New laws were enacted in Arkansas, California, Idaho, and Nebraska, and amendments to existing drainage laws were passed in ten other States.

It should be added that the experiment with hillside underdrainage in Georgia for the purpose of preventing the erosion of land, so harmful in the South, promises good results and will be watched with much interest by cultivators of hill land. Such an experiment requires several seasons to fully demonstrate the efficiency of the plan adopted. Future reports will doubtless give results, together with cost and the best methods to be employed in work of that character.

The report contains sixty-two pages, exclusive of eighteen diagrams and maps, relating to a variety of drainage problems the solution of which is of importance to the further development and improvement of the farming interests in many parts of the country.

SPEEDS OF THE WORLD.

A EUROPEAN engineer, Joseph Olshausen, began about fifteen years ago to measure the speeds of all creatures that he could study, and as a result he has collected a remarkable array of facts, each one based on absolute experiment, to show just how fast or slow hundreds of animals are.

He has found that man can attain remarkable speeds, but only by the use of artificial aids. A good pedestrian speed over good roads, he says, is a sixteenth of a mile in twelve seconds. The German soldier covers a little more than three miles an hour during an ordinary march that does not last too long. But after an eight days' march the distance covered in a whole day often is only 18¾ miles. In quickstep, however, the same soldiers have covered five miles an hour.

In athletes, the best speed recorded by the investigator was the initial velocity acquired by a broad jumper, who took the jump with a speed that carried him through the air at the rate of 393 inches in a second.

The maximum speed acquired by the average person in swimming comfortably is 39 inches a second, while oarsmen in an eight-oared barge acquired a speed of 197 inches in a second.

Skaters average from nine to ten yards a second, while runners on skids have made as much as 24 yards in the same time, and the jumper on skids has developed almost 40 yards velocity in a second. Of course, the latter velocity is maintained only for a very short distance. The man who made this record jumped 120 feet.

Ice boats skim over the ice at velocities that have reached 36 yards a second, or more than a mile a minute.

The fastest that has been done on a bicycle is the record of 66 feet a second.

The horse can gallop six miles in an hour for a considerable length of time. The swiftest dog in the world, the borzoi, or Russian wolfhound, has made record runs that show 75 feet in a second, while the gazelle has shown measured speed of more than 80 feet a second, which would give her a speed of 4,800 feet in a minute if she could keep it up for that distance.

The gazelle, however, swift as she is, is not as swift as the ostrich, for that homely but swift bird can run 98 feet to the second when he really gets down to it. But then he helps himself along with his wings, which may not be of much use for flying, but are exceedingly helpful in running.

The whale, struck by a harpoon and scunding in terror, has been known to dive at the rate of 300 yards in a minute.

The Virginia rainpiper has made measured flights of 7,500 yards a minute, and the European swallow has attained speeds of more than 8,000 yards.

A species of crow flies in great swarms from the German mainland over Heligoland every day, goes clear to the English coast and returns again every night. Close observation shows that these birds habitually fly 80 miles in three hours.

A species of falcon, known as the wandering falcon, flies from North Africa to Northern Germany in one unbroken flight, making the distance in 11 hours.

The slowest creatures are snails and certain small beetles. Some of them habitually move only a foot or two in an hour; but part of this slowness is due to the fact that they remain motionless at intervals. By measuring the distances covered by snails when they were kept going constantly, it has been found that the maximum speed of a good healthy snail is 5½ feet an hour.

The ladybug is a perfect racehorse compared with this, for it climbs a blade of grass at the rate of almost 2 inches in a second, or nearly 10 feet in a minute.

That speed, by the way, is exactly the average rate of speed which Nansen's Polar ship "Fram" drifted with the ice during her voyage of two and one-half years locked in the floes. And when Nansen left the "Fram" and pushed ahead with dog sledge, he didn't do so much better, for he rarely made more than nine miles a day.

None of the speeds made for any length of time compare with the speeds that are held for a second or a fraction of a second by some small creatures. Thus a jumping mouse found in the African desert leaps through the air at the rate of 800 feet in a second. Of course she clears only about 10 feet in a jump, and cannot keep up these jumps for any great length of time. Still, the little creature is swift enough to make a fast greyhound work hard for a quarter of an hour or so, till the mouse is wearied enough for him to outrun her.

Still quicker than this desert mouse is the common flea, which jumps with an initial velocity of 850 feet in a second. If the flea could keep this speed up steadily, without stopping once, it would cover almost 10 miles in a minute.

But even the flea's velocity is nothing when compared with the velocities in celestial space. Luminous clouds have made a measured speed of 15 miles a minute, while earthquake shocks have been observed to move at rates reaching 600 yards a second.

ELECTRICAL NOTES.

Twenty-four electric motors are used in the Olympia cotton mills, at Columbia, most of them rated at 150 horse-power, the total nominal capacity being 3,175 horse-power. They were purchased under a guarantee that they would carry 30 per cent overload without disadvantage. As a rule, the motors are belted to the shafts, but in some cases they are direct-connected to them. This is the case, for example, with 100,300 ring spindles driven by ten motors, the shafting and motors being attached to the ceiling of the story below, the belts coming up through the floor to the spinning frames. The shafting is 2 7-16 inches to 2 15-16 inches in diameter. The weight per spindle is 1.70 pounds for shafting, 0.309 pound for couplings, and 1.367 pounds for pulleys, a total of 3.376 pounds for the rotating parts of the installation. It has been found that the full load of the mill, as measured at the switchboard, was 2,597 horse-power, of which amount 552 horse-power, or 21.3 per cent, was expended in the transmission system; 5.13 per cent of the power is required by the openers and pickers, 14 per cent by the cards, drawing, and roving machinery, 53.9 per cent by the spinning department, 1 per cent by the slashers, 25.17 per cent by the looms, and the remaining 0.8 per cent by the cloth-room machinery.

A letter in a recent issue of the Times by Prof. Silvanus P. Thompson raises again the question of the dangers of the "live" rail. He states that: "In view of the numerous fatal accidents which have occurred at the 'live rails' lately laid down for electric propulsion on some of our railways, the public is naturally beginning to ask for something more than a makeshift protection. Unfortunately, neither the public nor the not-electrically-trained railway engineers appear to realize that the 'live rail' is itself already an obsolete device, discarded in the latest types of electric railway. In ten years' time there will probably be no 'live rail' left. I am no lover of overhead wires or conductors, in places, such as our city streets, where they endanger the public. But, if there is one situation where overhead conductors can be placed and maintained safely, that situation is over a railway, particularly an underground railway. Already the 'live rail' has been discarded in at least two places in the United Kingdom. It is an engineering blunder. I would therefore ask whether the time is not ripe for public opinion in some effective form, such as a departmental inquiry, to step in and prevent the railway engineers of England from committing our railway systems any further to this dangerous device."

A singular kind of so-called electric breathing figures was, according to a notice in No. 17 of the Physikalische Zeitschrift, produced by Mr. H. Axmann on conveying high-tension electric currents off to glass surfaces. In opposition to the familiar lightning figures, these figures proved permanent. Anyhow, the author possesses some glass plates ten years old, and which in spite of a most thorough cleaning will always again show the old figures on being breathed upon. If observed under the microscope, round drops of water of remarkable smallness are observed at these places, showing sharp outlines and refracting the light in a singular way. By no one of the usual methods was the author able to evidence any alteration in these glass plates. The figures were best produced by connecting one pole of the induction coil (50 centimeters explosive distance) with the edge of the glass plates, while the other was in communication with a metallic matrix lying on the glass, the direction of the pole being of no importance. A soft but not too slight pressure was found to be necessary to produce permanent figures. Soft metal pieces pressed on the plates by means of a spring seem to be quite suitable.

In the opinion of Technics, one of the most remarkable communications to the British Association was that of Mr. R. A. Hadfield, who described Dr. Heusler's magnetic alloys made from non-magnetic materials. When copper is alloyed with manganese and aluminium a substance is obtained which possesses high permeability. For a given percentage of manganese, the best results are obtained when the percentage of aluminium is, roughly, half that of manganese; this corresponds to one atom of aluminium to one of manganese. An alloy containing 60 per cent of copper, 26 per cent of manganese, and 14 per cent of aluminium is practically as magnetic as cast iron; unfortunately the alloy is very brittle, and cannot be drawn or forged. If iron is added to this alloy it becomes non-magnetic, so that we reach the conclusion that a magnetic substance can be made by combining substances which are themselves non-magnetic, and the addition of a magnetic substance renders the final product unmagnetic. It used to be thought that the magnetic properties of iron were due to some peculiarities of the iron atom, a conclusion to which it was hard to subscribe, owing to the circumstance that at high temperatures iron is non-magnetic. It now appears that the magnetic properties of a substance are due to some peculiarity in the grouping of the atoms within the molecule, or perhaps within the more complex aggregate in which atoms arrange themselves in solids.

ENGINEERING NOTES.

The Philadelphia, Lancaster, and Harrisburg Electric Railway, now under construction between these Pennsylvania points, will be the first single-phase system to be built in the East. The road will be about forty miles long.

Ten per cent of the fuel of the Paris, Lyons, and Mediterranean Railway consists of coal briquettes made from the slack and dust of the company's mines. The engineers find they can raise steam more quickly with briquettes than without them.

Recently, within the space of six hours, a large timber trestle viaduct spanning a gulch was replaced by a new steel girder bridge on the Peebles branch of the North British Railway. The two main girders, each weighing 22 tons, are 82 feet long and 7½ feet deep.

An incidental advantage of the open-hearth steel process over the Bessemer process is that it uses up old metal, whereas the latter depends solely on new. Any process which creates a regular market for scrap metal is of importance in the economic history of the world, as it tends to defer the day when our mineral resources shall be exhausted.

During the coming winter the Paris, Lyons, and Mediterranean Railway Company will greatly accelerate its express service from Paris to Nice. The distance from Paris to Nice is 675 miles, and the distance will be covered in 13 hours and 50 minutes. On the down journey the train will leave Paris at 9 A. M., and reach Nice at 10:50 at night; and on the up journey Nice will be left at 8:30 A. M., and Paris reached at 10:20, so that, for the first time, the Riviera will be brought within a day's journey of the capital.

It is said that Mont Blanc is to have its own railway. A decree published in the Journel Official declares that the laying down of a cog-wheeled railroad worked by machinery in the Department of Haute-Savoie between the railway station of Fayet-Saint-Gervais and the summit of the Aguille du Goûter would be of general utility. The necessary survey is to be made during the coming twelve months, and the work is to be completed in six years. Although the number and the sites of the stations have not been fixed upon so far, yet it is believed that, including the termini, they will be nine in number. Two journeys at least are to be made daily in either direction from June 15 to September 15. Each train will consist at most of two cars, each of a maximum length of 66 feet, and the rate of speed is not to exceed 5½ miles an hour.

C. Bach in Zeitschr. Vereines Deutsch. Ing. points out that though in many cases the usually accepted elastic limit suffices, there are a number of cases where the behavior of the metal under test does not conform to this, i. e., the test piece yields at a stress which is often quite considerably smaller than that at which yielding at first began. This is illustrated by autographic diagrams from test pieces of tough ingot-iron plate, the tests being made at room temperature and lasting 27 to 30 minutes generally. (The method of obtaining the records is described, and the curves given are considered to represent the progress of the phenomenon fairly though not with absolute accuracy.) The results for four different test pieces are shown below, where σ_1 = stress at which yield first took place, σ_2 = least stress at which the yielding continued after yielding had once commenced, Kz = tensile strength, and q = elongation at fracture:

Test-piece.	1	2	3	4	Mean.
σ_1	2911	2948	2880	2810	2882 kg. per sq. cm.
σ_2	2120	2063	2005	2095	2093 " "
K_z	3185	3159	3086	3172	3180 " "
q	33.4	35.4	36.6	32.2	34.7 per cent.

The values of σ_2 are seen to differ much less among themselves than those of σ_1. From these figures:

$\sigma_1 : Kz = 0.91$	0.83	0.90	0.80	0.88
$\sigma_2 : Kz = 0.67$	0.65	0.65	0.66	0.66

Diagrams from other specimens show some a less and others the same difference (about) between σ_1 and σ_2, but the foregoing figures are considered by the author to be sufficient to show that it must be decided which of the two stresses is to be considered as the yield point. The author is of opinion that for technical purposes the least stress at which yielding still goes on is of the greater importance, though for very accurate work σ_1 and σ_2 should be defined as the upper and lower limits of the yield respectively, the upper limit being defined as the stress at which the yield begins and the lower limit as the least value to which the stress sinks during the yielding, or the least stress under which the yield continues. It would be expected that the speed at which the test was made would have some influence, especially on the upper limit, but from experiments described no special influence was observed, and the view that with very slowly executed tests the difference between σ_1 and σ_2 would gradually vanish was also found to be unfounded. Other experiments, however, showed that thorough annealing lowered the upper limit considerably, and that the rapidity of the test has some influence. Finally, the author considers that in all materials where yielding takes place, the two limits must be recognized. What should really be taken as the yield point in metals which do not clearly show yielding, must be determined by a general resolution defining it, but it is observed that at Krupp's, in Essen, for their own purposes, the elastic limit is defined as that stress at which the permanent set (extension) reaches the amount of 0.03 per cent of the measured length of the test piece.

SCIENCE NOTES.

Prof. Barrett and Mr. Hadfield have found that the thermal conductivities of manganese-iron, nickel-iron, and tungsten-iron alloys vary in a manner exactly parallel to the variation of the electrical conductivities; in other words, when an alloy of iron and any one of the metals mentioned is found to possess a low electrical conductivity, it will also possess a low thermal conductivity.

The Field Columbian Museum has bought one of the most important archeological collections exhibited at the St. Louis Exposition at a price said to be nearly one hundred thousand dollars. An assortment of samples of the work of the Calchaqui Indians, the largest ever secured, makes up much of the display. The collection was made by M. Zavaleta, a native resident of the Argentine Republic, who spent fifteen years in the work. Vases, cups, and water jugs of ornamented pottery in primitive tribal design, war clubs and implements of stone, bronze and copper dishes, arrow-heads of stone and metal, and more than one hundred skulls are included in the collection. Many of them date back one thousand years. The relics were dug out of tombs of the primitive chiefs and their families. Some of them were buried as deep as seventy feet.

At the Anthropological Congress recently held at Greifswald, Prof. Uhlenhuth described at considerable length the results of experiments he had undertaken with the view of ascertaining whether any closer affinity exists between the blood of the man-like apes and that of man than between the latter and the blood of the lower monkeys and mammals in general. The result is to show that although it is perfectly easy to distinguish between human blood and that of the lower mammals, it is much more difficult to demonstrate under the microscope a satisfactory distinction between the former and that of apes and monkeys. But this is by no means all; for, whereas the resemblance is greatest between the blood of man and that of man-like apes, it becomes less strongly marked when that of the lower Old World monkeys is compared, still less so in the case of the American monkeys, and least of all when the blood of the lemurs is under comparison. This is exactly what might have been expected to occur, seeing that the lemurs depart most widely of all the primates from the human type.

An extremely interesting discovery of the remains of extinct mammals has recently been made during excavations undertaken for the foundations of the Ganges bridge at Allahabad, India. The remains include those of one or two species of hippopotamus, of a wild ox, and of an elephant, all belonging to extinct species. Apparently all these species are identical with those long known from the valley of the Narbada, considerably further south in India; but it is possible that the Ganges bones, like others discovered in the early part of last century in the valley of the Jumna, may belong to a somewhat later portion of the Pleistocene epoch. In all probability the creatures they represent were contemporaries of the early human inhabitants of India; and the special interest of the discovery lies in the possibility that it may give rise to investigations for the purpose of ascertaining whether human remains may not occur in the same deposit. In connection with the former existence of hippopotamuses in India, it may be remarked that we have yet to learn why these animals died out while elephants survived.—Knowledge.

Spectroscopic observations of the rotation of the sun were undertaken by J. Halm (Roy. Soc. Edinburgh, Trans.) in hope of gaining new material for discussing the law of the sun's rotation, which has hitherto been mainly dependent on observations of sunspots, thereby precluding from the discussion the polar regions of the photosphere, where sunspots rarely or never occur. Observations were made of the displacements shown by the Fraunhofer lines at opposite limbs of the solar disk, the instrument employed being a diffraction grating spectroscope of great power. To increase the stability of the apparatus, the sunlight was thrown into the condensing lens from a siderostat. To obviate the use of double reflecting prisms for the comparison of the two opposite limbs of the sun, the author employed a heliometer, and by separating the two components of the objective he could place any two diametrical points on the sun's limb in juxtaposition on the slit plate. A position circle was used to determine the exact orientation of the points examined, and it was of course necessary to introduce a small correction for the rotation of the field, which is a well known feature of the siderostat. The spectroscope consisted of a collimator of 4 inches aperture and 50.5 inches focal length, passing the light to a plain Rowland grating 5 inches long and 3½ inches wide, with 14,438 lines to the inch. The third order spectrum was then examined with a viewing telescope of 4.1 inches aperture and 60 inches focal length, and fitted with a Cooke wire micrometer. The observations have extended over the period 1901, August 13, to 1903, November 6, during which time 564 determinations of the rotational velocity were made. These have been divided into two groups for discussion, according to their epoch with respect to the solar cycle of spot activity. Curves plotted from the results obtained are given, from which it is at once evident that the two groups differ materially from each other. Agreeing fairly well near the equator, the rotational velocities near time of maximum activity show greater values in higher latitudes than the velocities of similar latitudes at times of minimum spot activity.

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